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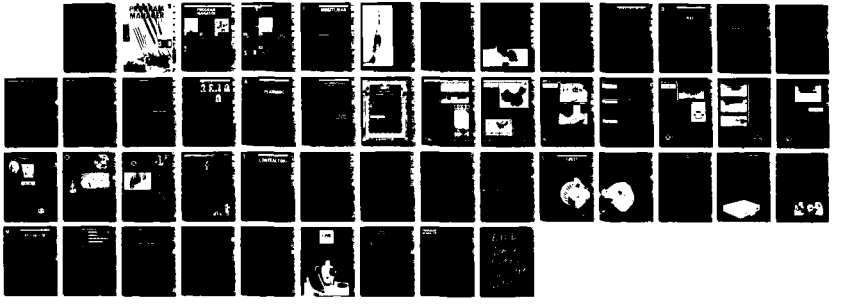

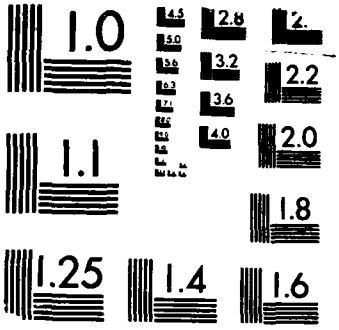

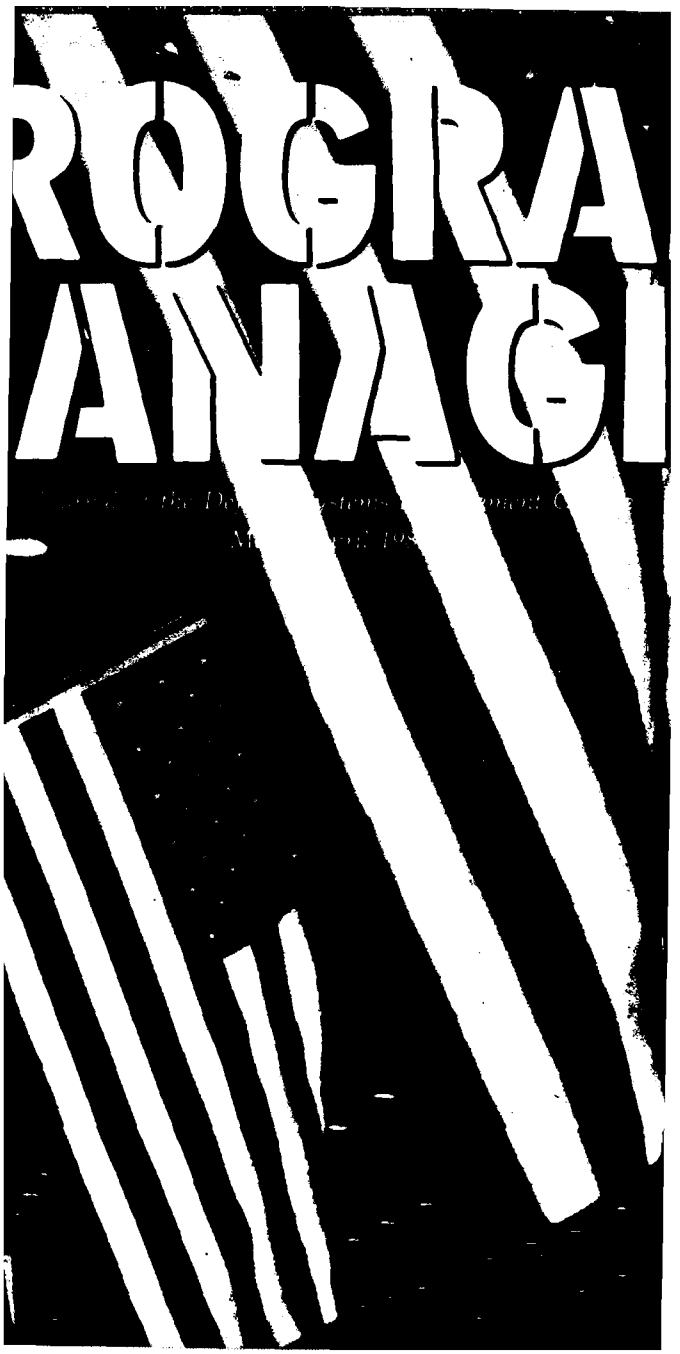
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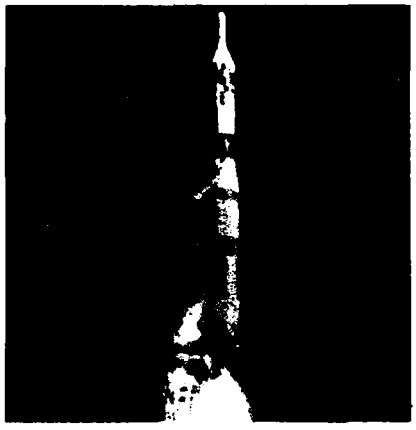

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Il-woon Kim

Program managers are vitally interested in product quality, delivery time, and cost.

Whenever in this publication "man," "men," or their related pronouns appear, either as words or parts of words (other than with obvious reference to named male individuals), they have been used for literary purposes and are meant in their generic sense. ■

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MINUTEMAN

A MODEL R&M PROGRAM

Major Julius F. Sanks, USAF

It is contended that highly reliable systems cost more than less reliable ones. This belief is used to assert that budget limitations, schedule constraints, or technical risk restrict emphasis a program can give to reliability and maintainability (R&M). The Minuteman program contradicts this assumption. Minuteman was designed to provide large amounts of firepower at low cost, and heavy emphasis on reliability and maintainability was, to a large degree, responsible for its success. The outstanding R&M character-istics of the Minuteman allowed the Air Force to field it in far greater numbers than possible with earlier Intercontinental Ballistic Missile (ICBM). Minuteman program managers turned to R&M to solve management problems. Indeed, there are remarkable similarities among the cost-constrained, schedule-driven, high-risk Minuteman program and modern programs facing the same problems.

When viewing acquisition programs from the 1950s and 1960s, it is assumed program managers did not face the fiscal and schedule contraints we see today. It is maintained that in times of strategic superiority, the defense establishment did not face today's challenge to provide sufficient force in the face of technological risk, budget deficits, strength parity and politics. Yet, developers of Minuteman faced these same obstacles. If, facing the same problems we do, they were able to field a system of high reliability and maintainability in 1962, it seems only reasonable that we should be able to do the same today. To understand why this program placed high emphasis on R&M, we must understand the environment in which the system was acquired.

In the late 1950s the Soviets were perceived to be ahead in missile forces; many people feared a "missile gap." It was estimated that the Soviets could have as many as 1,000 missiles by the mid-1960s. In contrast, an accelerated, but traditional, U.S. program could result in a maximum of 300 ICBMs by 1963.[1] The reason for the shortfall was the high cost and difficulty of manufacturing liquid-fueled missiles. Early liquid-fueled ICBMs were too costly for production in sufficient numbers to counter the perceived threat. The Polaris program, with its limited range and payload, was not thought to mitigate the threat.[2]

The response was a new ICBM program. If existing systems, or systems then in development, could not match the inventory believed available to the Soviets, then a better missile would have to be developed. The new program resulted in the Minuteman. By the end of 1957, conceptual studies were complete and the system was ready for what is now known as full-scale development. The new ICBM represented an enormous increase in fielded weapons (see Figure 1).

The program as conceived was to be a small, low-cost missile using solid rockets and inertial guidance. The crucial factor was economics. If an inexpensive system, it could be produced in sufficient numbers to offset the Soviet advantage; and if it could respond quickly enough to launch on warning, it would be a powerful deterrent.

Figure 1. Missile Forces Planned

VEHICLE	NUMBER
ATLAS	132
TITAN	108
THOR	80
JUPITER	45
POLARIS	464
MINUTEMAN	600-2000
TOTAL	1429-2829

Low cost and rapid reaction shaped the Minuteman program. To meet the threat, the new system had to be available in large numbers and have a short response time to permit launch before destruction by incoming reentry vehicles. Large numbers required low acquisition cost and low operations and maintenance cost. Short response time required a major departure from the existing Intermediate Range Ballistic Missile (ICBM) concept. Earlier missiles needed about 15 minutes to launch because the guidance and control systems were not normally operating and some missiles also needed fueling. This was considered insufficient time to survive an ICBM attack; 1-2 minutes was needed to meet the threat.[3] This short response time meant, for the first time, that the guidance and control system would have to remain operating constantly. A simple method of storing fuel in the missile was needed to escape the complex fuel-handling systems used in earlier large missiles.

Air Research and Development Command, the predecessor of Air Force Systems Command, developed a missile intended to meet the threat. The new ICBM would be housed in either fixed or mobile (rail, truck, or barge) launchers, be smaller than previous ICBMs, and have three configurations. The first configuration, "Sentinel," would be a three-stage ICBM. By using only the first and second stages, the second configuration, "Minuteman," could be used as an Intermediate Range Ballistic Missile (IRBM). The "Scout" would employ only the first stage to perform tactical missions.[4] The ICBM version, named Minuteman, was the only one fielded.

This seemingly straightforward program was complicated by many difficulties. Other systems were competing for funds; the development of Polaris, which first flew in 1958, was far ahead of Minuteman and Polaris and difficult to match in the competition for funds because of its apparent

■ *Major Sanks is a reliability and maintainability engineer at Headquarters, Air Force Systems Command, Andrews Air Force Base, Md.*

Titan I

invulnerability. Minuteman faced competition from manned systems. The B-70 and Dynasoar were in development, the B-52 was in production, and the Air Force was progressing toward a nuclear-powered bomber. Polaris and the Atlas and Titan I ICBMs enjoyed the highest priority in the Department of Defense;[5] Minute-man did not.

Technical risks made senior decision-makers reluctant to support Minuteman. At the time, Polaris represented the largest solid rocket motor in existence. There was considerable doubt that a rocket motor large enough for Minuteman could be cast, or that effective nozzle vectoring could be devised for the large gas flows involved. In addition, guidance and control was viewed as a major problem. The guidance system had to be accurate enough to hit targets with the smaller weapons the Minuteman carried, and had to operate constantly if the fast response time was to be achieved. Finally, there was risk in the concept of hot launch from a silo. During a hot launch, the missile leaves the silo under its own power. Earlier ICBMs were lifted out of the silo by elevator prior to launch. Whether or not a missile could survive a hot launch was unknown. In September 1958, doubts concerning Minuteman caused the Office of the Secretary of Defense to defer all Minuteman procurement until further notice.[6]

As a result of skepticism surrounding these risks, as well as the competition for funds, Minuteman faced austere funding. The highest defense priority rating of "DX" was not awarded to Minuteman until August 1959, 1½ years after the start of full-scale development.[7] At about the same time, the Air Force Chief of Staff, General Thomas D. White, listed replacement of the B-47 as his top priority; the Commander in Chief, Strategic Air Command, General Thomas S. Power, listed as his top priority funds for the B-52 and KC-135.[8]

The program request for $25.5 million in initial start-up funds netted $20.5 million.[9] The original FY59 request for $259 million was reduced by the Secretary of Defense to $125 million—a 52 percent reduction. In fiscal 1959, the program actually

received $50 million from the Air Force and another $25 million from the Advanced Research Projects Agency.[10] Thus, the program was forced to continue development in an environment of political uncertainty and limited funds but still required to meet the IOC date of 1963. In May 1959, this became subject to change when, in response to a belief that the program could tighten its schedule by adding more production capability, the program's required IOC date was moved back a year to 1962 with no increase in priority.[11]

These limits led to formulation of the program's actual R&M goals. The first goal, continuous availability, was needed to meet the reaction time required. Of course, successful flight was required. Maintenance needs had to be as small as possible if a large Minuteman force was to be fielded within support cost limits. Low production cost was imperative if sufficient missiles were to be manufactured within the available budget. These basic R&M requirements forced Minuteman to be a simple, highly reliable system, with design goals that are amazingly similar to the five Air Force operational R&M goals of today.[12]

Designers addressed two environments—in the launcher and in flight.[13] They differed considerably. The benign environment in the launcher requires very long operating times; the flight environment is short-lived but extremely stressful.[14] The two environments combined to require a far more rugged design than had ever been attempted in ICBMs.[15]

Avionics design required new techniques. Electronics parts failure modes and their prevention were largely unknown. In the past it had not mattered; one simply replaced the part. But, failures had to be prevented for the system to remain continuously available with low manpower.

To solve the avionics problem, the most extensive and innovative reliability program attempted up to that date was devised. The prime avionics contractor estimated that 25 to 30 percent of its costs went into the reliability effort.[16] That effort involved extensive parts control with automated testing to avoid handling of individual components. Every part supplied by vendors received 2,100 hours (about 90 days) of testing, with rigid reject criteria. Twenty percent of the parts underwent additional testing. Seventy-five percent of the parts getting the extra testing established previously unknown wear-out characteristics. The other 25 percent identified new failure modes. Data were returned to vendors for further parts improvement.[17] These testing efforts were revolutionary. Statistical process control kept quality up to standards at all levels of assembly. Virtually all vendors had to build either new production lines or complete new facilities to qualify for the program.[18] The effect on Minuteman parts quality has been far-reaching. The emphasis on parts control started in Minuteman has continued on space and missile systems to the present day. The end-result is higher yields and, in turn, lower costs. In the guidance and control system, "the average cost per electronic circuit element [was] reduced by an order of magnitude since early Minuteman I, despite inflation."[19] Reliability of the solid rocket motors, a major risk area, was addressed. More than twice as large as the biggest solid rockets then in existence, the Minute-man first stage was a significant technical challenge. Program managers recognized the need for better cases and insulation and the need for new, higher-energy propellant to meet range and payload requirements.[20]

The solid rocket motor program involved extensive testing and risk avoidance, where possible. Two contractors were hired for each of the three stages; one was designated as prime, one as backup. The contractor with the best design would survive the down-select.[21] A dual strategy for propellant was employed—a low-risk, existing propellant was identified for possible use (and limitations on missile capability) while development proceeded on a higher-risk, higher-energy propellant. Ultimately, this improved propellant was used on all three stages.[22]

Problems remained with rocket motor insulation and with thrust vectoring. Extensive engineering and testing efforts controlled both problems by the fall of 1960 although performance limitations on the stage two motor had to be accepted temporarily. This limitation was mitigated by developing the A-model, installed in the first launchers at Malmstrom Air Force Base, Mont., with the B-model, using an improved second stage, installed at the second wing at Ellsworth Air Force Base, S.D.[23] Developers perfected the stages just in time for the first launch date of Feb. 1, 1961. Two other questions needed answering. First, the effects of hot launch out of a silo were unknown. Second, the missile would remain launch-capable, in silos, for long periods of time. How would propellant stand up to long periods of dormancy? No one knew, and the program schedule would not allow time to find out.

The risk of hot launch was addressed by examining alternative launch tube designs. The simple cylindrical silo was less expensive but a risk, because the missile would be subjected to its own plume upon launch. Safer alternatives were more expensive. The first of these concepts was the concentric liner. In this, the rocket plume was shielded from the missile by a large metal cylinder surrounding the missile. An alternative was the "U-tube," in which the launcher was U-shaped to divert gasses away from the missile. Two prototype silos were built at the Air Force Rocket Propulsion Laboratory (AFRPL) to test the effects of hot launch. These launchers were configured as simple silos. Their diameters could be changed to determine the minimum safe diameter; the goal was to find the smallest safe dimension that would allow launch. Tests at AFRPL where missiles were launched with a tether to limit altitude showed that the missile accelerated out of the hole quickly enough to receive no damage.[24] The final question involving the rocket motors was that of propellant aging. Designers were fairly confident the propellant would last long enough, "perhaps for 3 years."[25] To confirm this estimate, an aging and surveillance program was devised to determine the effect of time on propellant performance. This program, involving statistical analysis of data resulting from tests of components stored just for that purpose, showed that the propellant would last much longer—and it has. The aging and surveillance concept continues today on Minuteman and recently was applied to other systems.

Program managers had strong motivation to limit manpower requirements. An estimate showed

elimination of one 24-hour manpower slot would save $350,000 to $500,000 in 1959 dollars. In addition, there were economies of scale to be considered. Spending $100,000 to save $1,000 per launcher made sense in a program consisting of hundreds of missiles.[26]

The program achieved manpower savings two ways. First, operator manning was reduced. Earlier ICBMs needed four people to launch a single missile but Minuteman used a new operating concept—automation—to reduce crew strength to four people for 10 missiles. Automated launch sequences had been used in the past but Minuteman went further. Earlier, people decided whether or not to abort launch when an anomaly was detected.[27] In contrast, the Minuteman system made the decision and informed the crew by launching or shutting down. This approach was forced upon the program by manpower limitations and because a crew could not respond to missile indications fast enough to make the needed reaction time if the missile could launch with the anomaly present.

The emphasis on manpower savings continued with the maintenance concept. While Minuteman did not emphasize maintainability to the extent we expect today, it was, perhaps, ahead of its time. The line replaceable unit concept (called "drawers" in the Minuteman program) had been used before, but the Minuteman goals were to reduce the need for maintenance (high reliability) and the time the maintenance technician had to spend on site. Minuteman program managers faced the same limits on manpower and technician skill levels seen today.[28] Unmanned sites were to be remotely monitored. This required automated health monitoring—built-in test (BIT)—and the crew notified maintenance when attention was needed. Minuteman's BIT was designed to minimize on-site checkout; it identified what part of the missile had failed.[29] This BIT was sophisticated enough for the depot to identify what component in the guidance section had failed.[30] On site, technicians performed maintenance with a minimum of experience.

While Minuteman did not emphasize maintainability to the extent we expect today, it was, perhaps, ahead of its time.

The missile guidance and control system was expected to fail most often because it ran constantly. The original maintenance concept called for the entire missile to be a depot repair item if anything failed. Since this would mean many missile replacements, the program changed the baseline to make the guidance and control system replaceable at the organizational level.[31] Even so, the missile was designed to need only two levels of repair (ground electronics are three-level repair items). As a result, missile replacement, a time-consuming and manpower-intensive task, remains a rare event. Minuteman has pursued reliability growth. Later models of Minuteman, the LGM-30F (Minuteman II) and the LGM-30G (Minuteman III), were improved in the guidance system. A case in point is the onboard computer. The Minuteman I represented the first large-scale military use of semiconductors; the Minuteman II was the first program to make large-scale use of integrated circuits.[32] This resulted in the Minuteman II computer, the D-37C, achieving more memory with fewer parts in far less volume. This may not seem impressive in today's world of microcomputers, but it must be remembered that the D-17B (Minuteman I computer) design effort began in 1959, flew in 1961, and was fielded in 1962—only a 3-year development. Similarly, the D-37C design was begun in 1962, flew in 1964, and reached the field in 1966—just 4 years of development. The program's willingness to use revolutionary technology where needed is largely responsible for Minuteman's outstanding guidance and control performance.

Polaris

The rest of the program was designed to achieve similar improvements. With estimated costs of just $1 to $2 million for an installed missile versus $10 million for predecessors, Minuteman pursued an 80 percent improvement.[33] Its reaction time of 1-2 minutes beat the earlier missiles by 90 percent. The real savings of Minuteman is in manpower. Atlas needed more than 66 people per missile to remain operational; but, the first Minuteman needed just nine.[34] The current Minuteman weapon system needs even less.[35] These improvements are a result of the emphasis on reliability and maintainability early in development.

During the years, Minuteman has seen many evolutionary improvements intended to retain high reliability and maintainability while minimizing design and support costs. The idea of evolving new weapons, rather than creating new designs, is generally credited to the Soviets.[36] The Minuteman program has used this philosphy since its start. The guidance and control system has evolved continuously, using combinations of old and new components to achieve improvements. These improvements, in turn, led to improved flight controls on the stages. At the same time, many components remain common to all models of Minuteman.[37]

A measure of the program's willingness to take needed risks to achieve its goals can be seen in the first launch attempt. Before this first flight, missile development was a leisurely activity in which components would be flight-tested on other missiles, then at reduced range or with incomplete missiles, and finally at full range. Minuteman was different. Forced to meet a tight schedule and faced with numerous skeptics, the program managers took a chance. The first launch attempt was a missile flown at intercontinental ranges—a feat thought impossible by experienced missile people.[38] This successful first flight received little attention at the time, possibly because Project Mercury put a chimpanzee into space the day before.

During the years, the Minuteman program has established a tradition of high reliability and combat readiness; thus, we expect all our ICBMs will perform as well. It is taken for granted that ICBMs always will be ready. The truth of the matter is that the Minuteman program achieved such success not because of the benign environment "in the hole," or because the design was a simple one. It was because the program managers were willing to emphasize reliability and maintainability from the beginning. A strong reliability and maintainability program was the only reason the Air Force was able to field a force of 1,000 Minuteman missiles. If the system had performed the same as previous missiles, the number would have been far less for the price. Minuteman many represent the only time the country set out to prevail over a real or imagined superiority in Soviet inventory; and its success was largely due to its strong R&M effort.

The program recognized the truth of the statement "quality and reliability must be built into components and cannot be tested into them."[39] This is the real lesson of the Minuteman program. The Minuteman R&M approach in a technically risky, cost-constrained, schedule-driven environment demonstrates that the primary requirement to achieve high reliability and maintainability is the *willingness* to achieve it.■

Footnotes

1. Laquer, Walter, *A World of Secrets - the Uses and Limits of Intelligence* (New York: Basic Books, Inc., 1985), p. 154. Cf. U.S. Congress, Senate, Committee on Foreign Relations, *Developments in Military Technology and Their Impact on United States Strategy and Foreign Policy*, by the Washington Center of Foreign Policy Research, The Johns Hopkins University, Study Paper 8 (Washington, D.C., U.S. Government Printing Office, 1959), passim but especially pp. 50-61. Hereafter referred to as Senate Report.

2. Senate Report, p. 57.

3. Ibid., pp. 54 and 65.

4. Neal, Roy, *Ace in the Hole* (Garden City, NY: Doubleday & Co., Inc., 1962), pp. 84-89.

5. Reed, George A., "U.S. Defense Policy, U.S. Air Force Doctrine and Strategic Nuclear Weapon Systems, 1958-1964: The Case of the Minuteman ICBM" (unpublished Ph.D. dissertation, Duke University, 1986), p. 126.

6. Ibid., p. 87.

7. Ibid., p. 129.

8. Ibid., p. 123.

9. Ibid., p. 80.

10. U.S. Congress, Senate, Committee on Appropriations, *Department of Defense Appropriations for 1959, Hearings*, before a subcommittee of the Committee on Appropriations, on H.R. 12738, 85th Congress, 2nd session, 1958, p. 413. Reed (p. 80) reports this $239 million request was for FY58 and FY59.

11. Neal, pp. 117-120; Reed, p. 125.

12. Increase combat capability; increase the survivability of the combat support structure; decrease mobility requirements; decrease manpower requirements; and decrease cost. See Air Force Regulation 800-18, Oct. 1, 1986, p. 1.

13. Klass, Philip J., "Reliability Is Essential Minuteman Goal," *Aviation Week with Space Technology* [hereafter *Aviation Week*], Vol. 71, No. 16, Oct. 19, 1959, p. 69.

14. Although the MIL-HDBK-217 "fighter uninhabited" environment is usually assumed to be the most difficult, for many components "missile launch" is even more demanding.

15. Klass, p. 69.

16. Ibid., p. 79. The actual cost was reported to be $18 million. See "Perfection Wanted," *Electronics*, June 17, 1960.

17. Ibid., pp. 71-73; also Stranix, Richard G., "Minuteman, Catalyst for Reliability," *Electronics Industries*, a Chilton Publication, Dec. 1960, p. 99.

18. Stranix, p. 98; also Klass, p. 75.

19. Wuerth, J. M., "The Evolution of Minuteman Guidance and Control," DTIC Technical Report X75-528/201, June 11, 1975, p. 10.

20. Neal, pp. 66, and 135-136; also Butz, Jr., J. S., "New Methods Applied to Minuteman Cases," *Aviation Week*, Vol. 71, No. 14, Oct. 5, 1959, p. 139.

21. Neal, pp. 113 and 135.

22. Ibid., pp. 135-136 and p. 138.

23. Ibid., pp. 162-164.

24. Ibid., pp. 147-154; also "Minuteman Tests Yield Silo Design

Data," *Aviation Week*, Vol. 71, No. 23, Dec. 7, 1959, pp. 57-61.

25. "First Details of Minuteman Configuration," *Aviation Week*, Vol. 71, No. 11, Sept. 14, 1959, pp. 33-34.

26. Sweeney, Richard, "Minuteman Support Refined to Cut Costs," *Aviation Week*, Vol. 72, No. 11, March 14, 1960, p. 65.

27. The typical earlier approach was described in Young, Lewis H., "How They Keep Thor Operational," *Control Engineering*, December 1959, pp. 89-94. Cf. Sweeney, p. 71.

28. Sweeney, pp. 65, 67, and 71-72. Also Neal, pp. 85-87 and 130-131.

29. Sweeney, p. 71.

30. Mr. D. Petry, private interview, Andrews AFB, Maryland, October 1987. Mr. Petry was a reliability engineer assigned to the Aerospace Guidance and Metrology Center, Newark AFB, Ohio, in the early 1960s.

31. Neal pp. 129-130.

32. Wuerth, p. 8.

33. Senate Report, p. 80. Later, the Air Force announced that the cost of a "war-ready Minuteman in its launching silo" was about $3.5 million. This still represents a cost reduction of roughly 65 percent over earlier missiles. See Twiss, Robert, "Minuteman Cost-Cutting Aims Outlined," *Missiles and Rockets*, June 24, 1963, p. 40.

34. Neal, p. 131; also "Minuteman May Get $1 Billion in Fiscal '62," *Aviation Week*, Vol. 73, No. 21, Nov. 21, 1960, p. 30.

35. Major R. Stevens, HQ SAC, telephone interview, September 1986.

36. Dunlavey, Terry E., "Soviet Weapon Systems Design Philosophy," *Program Manager*, Vol. XV, No. 5, September-October 1986, p. 7.

37. Wuerth, pp. 6-8 and 13.

38. Neal, p. 28.

39. Klass, p. 73.

I see that the old flagpole still stands. Have your troops hoist the colors to its peak, and let no enemy ever haul them down.

—Douglas MacArthur

Deception More and Less Than Meets the Eye

Deception can be an advantageous part of everyday life, whether in a silk flower's bloom or in more aggressive environments.

On the battlefield, deception is used to trick opposing forces into acting against their own interests, by presenting targets to enemy weapon crews. This creates false impressions of U.S. intentions, to fool enemy commanders into action.

Battlefield deception works in two ways—decoys draw enemy fire and divert the attention of enemy commanders which reduces the vulnerability of the U.S. Army's equipment and soldiers.

Currently, the Fort Belvoir Research, Development and Engineering Center is working on a series of multispectral close combat decoys that very closely replicate some weapon systems. The decoys of painted fabric skin stretched over a collapsible frame can draw enemy fire which enables our forces to counterattack. Other decoys will mimic vehicles and equipment common to logistics operations and field command posts. They will give a false picture of our intentions to delay and disrupt enemy intelligence.

The Center is also working with the Army Communications-Electronics Command, the Missile Command and The Laboratory Command on an integrated program to study the complete spectrum of threat sensors and deception.

During the past year, the Center has evaluated systems ranging from simple billboard tank decoys to complex communications systems. These evaluations were so successful that the Army directed immediate limited acquisition and fielding of four decoy systems. Projected fielding of these systems is to be completed within 2 years.

Decoys and battlefield deception are becoming an increasingly important part of the Center's countersurveillance and deception program. However, camouflage is also a prominent factor in preventing the enemy from knowing our intentions which identifies the Center's second major thrust area with this project—camouflage.

A new three-color camouflage pattern is being developed to replace the four-color pattern in use since 1974. This new system psychologically disrupts the image shape and perimeters to the viewer's eye. Broad bands of black are used to break up the straight lines and sharp corners that cause a man-made object to stand out from its more irregular natural surroundings.

Converting to the new three-color pattern is a major undertaking. The transition difficulty is eased by the Center's use of computer technology which creates the new camouflage designs in a fraction of the conventional drafing time. The computer system can create scale drawings and develop camouflage patterns for specific pieces of equipment using a simple photograph as a reference.

When the camouflage patterns are designed, they are painted on equipment with a special coating resistant to chemical warfare agents. These agents must also meet EPA environmental standards. Eventually, Army camouflage experts hope to combine the computerized pattern production technique with robotic technology to automatically paint equipment in the Army's manufactures shops.

In addition to disruptive-paint patterns, camouflage nets have been designed to conceal Army vehicles and equipment. Their versatile, flexible form allows several nets to be joined forming tailor-made nets for concealing large or irregularly shaped equipment or for their individual use.

The Center's camouflage developments have the potential to save thousands of lives and billions of dollars in equipment, making it one of the best investments around. Not a very deceiving notion itself when its importance and significance are viewed in proper perspective.■

■ *The Fort Belvoir Research, Development and Engineering Center is part of the Army Troop Support Command, St. Louis, Mo.*

PERSPECTIVES

MILITARY AND CIVILIAN R&D

A Comparison of Expenditures

Lieutenant Colonel Blair A. Peterson, USA

Defense research and development (R&D) expenditures often have been criticized as being in conflict with needed expenditures for R&D activities in non-defense (civilian) related areas. To provide perspective in this regard, this article will draw comparisons concerning expenditures for defense and non-defense R&D during the past 25 years.

Three primary comparisons will be highlighted. First, the source of funding for R&D efforts will be illustrated. Second, the activity performing R&D work (performer) will be described. Finally, the character or nature of defense and non-defense R&D work itself will be compared. Using these comparisons you will see significant differences between defense and civilian R&D efforts.

Sources of Funds

Table 1 is a summary of funds sources, on a national level (total U.S.), for R&D expenditures since 1960. From this compilation, you see civilian funding as a source for R&D expenditures has grown steadily since 1960, and by 1985 accounted for 53 percent of all national R&D funding. On the other hand, federal funding as a portion of total national funding for R&D shows a consistent decline; i.e., from a high of 64 percent in 1960 to 47 percent in 1985.

Defense related expenditures, which always have accounted for the majority of federal funding support of R&D, have shown the largest degree of change during the 25 years covered by data in Table 1. From a 1960 high of 52 percent of all national expenditures for R&D, defense related R&D expenditures dropped to a low of 22 percent in 1980. During the Reagan Administration, the defense related share of national R&D expenditures regained some of its previous position, as it accounted for 30 percent of the national total by 1985.

Table 2 outlines federal funding for R&D during the same period; 1960-1985. When defense related R&D expenditures are viewed as a share of total federal R&D expenditures, a different trend is seen compared to the national R&D expenditures discussed above and outlined in Table 1. Most obvious is the dominant and consistent role of defense in federal R&D ecpenditures.

The fact that national defense is a "public good" helps explain why federal funding for defense R&D plays a dominant role; without federal funding, or for defense in general, it is unlikely the civilian sector would react to satisfy this need. General absence of the "invisible hand" of market forces creates a static market failure in terms of defense spending economics. However, given the fact that there is a market (a monopsony) for defense related goods and services, stimulus exists for civilian investment in defense R&D. This private-sector source of funding for defense R&D is classified as independent research and development (IR&D).

The IR&D is a program whereby the government provides reimbursement to private contractors for a portion of their investment in R&D work, when such investment contributes to national security. For projects appearing to have direct security relevance, the government allows contractors to recover, as overhead, a certain level of IR&D costs they incur. These overhead charges are allocated to federal contracts on the same basis as general and administrative costs.[1] Each major contractor is required to negotiate in advance an agreement on the size of its IR&D program, following a technical evaluation by the Department of Defense. A company spending beyond its negotiated IR&D ceiling may not allocate the extra costs to Department of Defense contracts.[2] Payments under the IR&D program, since they are made as indirect costs (overhead) under defense contracts, are not listed separately in the DOD budget under the research and development appropriation.[3] This understates the actual levels of federal spending on defense R&D.

The Department of Defense provides reimbursement for about 37 percent of the total IR&D incurred by industry each year. The National Air and Space Administration, which participates in the IR&D program, provides about 2-3 percent reimbursement.[4] You should note, however, that approximately 60 percent of IR&D costs incurred by industry for defense related R&D are not recovered by firms from the IR&D program. These costs can be considered additional defense R&D expenditures, but source of the funds is the private sector rather than the government.

Universities and colleges and other non-profit institutions provide funding support that contributes to national expenditures for R&D. Since 1960, the contribution from these sources has increased from about 2 percent of the national total to the current figure of about 3.5 percent. These figures exclude any federal or industry contributions to universities and colleges for R&D; however, they do not exclude funds received from state and local government sources.

During the past 25 years there have been significant shifts in national expenditures, federal and civilian, for R&D and the specific federal support for defense R&D. It appears the

Table 1. National Expenditures for R&D by Source of Funds: 1960-1985

YEAR	NATIONAL TOTAL (CONSTANT) (1972) DOLLARS*	FEDERAL FUNDING			CIVILIAN FUNDING
		% DEFENSE RELATED	% SPACE RELATED	% CIVILIAN RELATED	% TOTAL
1960	$ 19,634	52	3	9	35
1965	26,898		21	11	35
1970	28,613	33	10	14	43
1975	28,153	26	8	17	49
1980	35,122	22	7	18	53
1985	45,863	30	6	11	53

*All dollar figures in millions

Source: Adapted from National Science Board, *Science Indicators: The 1985 Report* and other National Science Foundation data.

Table 2. Federal Expenditures for R&D by Source of Funds: 1960-1985

YEAR	TOTAL FEDERAL (CONSTANT 1972) DOLLARS*	% DEFENSE RELATED	% ALL OTHER
1960	$ 12,674	81	19
1965	17,445	50	50
1970	16,316	52	48
1975	14,537	51	49
1980	16,542	50	50
1985	21,374	68	32

*All dollar figures in millions

Source: Adapted from National Science Board, *Science Indicators: The 1985 Report* and other National Science Foundation data.

civilian sector has been willing to fund non-defense related R&D as the federal government has lessened its contribution. This is evident in the continued growth of national R&D expenditures as measured in constant 1972 dollars. On the other hand, defense related R&D expenditures, as measured in constant 1972 dollars, declined between 1960-80 with the general decline in federal funding support for R&D. Only since federal expenditures for R&D increased in 1981 has defense related R&D increased. This seems to support the notion that the market will fail to provide support for efforts considered "public good," such as defense.

Performers of R&D

The industrial sector performs the majority of R&D in the United States, consuming about 73 percent of all R&D expenditures in 1985. In that year, the federal government accounted for the next largest share of national R&D performance with about 12 percent. Universities and colleges, federally funded research and development centers (FFRDCs) administered by universities, and other non-profit institutions accounted for the remaining 15 percent in 1985.[5]

During 1960-85, there were significant differences in the funding provided (source) by the federal government for R&D and the amount of funds used by the federal government as the actual performer of R&D activities. In every year during this period the federal government provided far more funding for R&D than it has consumed as the actual performer of the R&D activities. Conversely, in every year during this period non-federal funding, as a source of R&D, has been significantly less than the volume of funds the private sector has consumed as the performer of R&D activities.

While this relationship may seem intuitively obvious, it highlights another feature about federal R&D spending that may be less obvious. As federal support for R&D, as a source of funds, has declined during the past 25 years, the portion of R&D performed by the federal government has remained constant. Table 3 illustrates this point.

Table 4 provides a breakdown of recipients (performers) of funds spent by the Department of Defense for R&D in recent years.

In-house Department of Defense R&D activity is performed in more than 100 organizations, the majority of which is by DOD laboratories within each of the military services. The Navy controls most of the laboratories, partly because there is no industrial base for much of the work it undertakes and partly because of explicit choice.[6] Examples of these Department of Defense laboratories include Army's Harry Diamond and Signal Warfare Laboratories, Naval Weapons Center (China Lake), and the Air Force Cambridge Research Laboratory.

The FFRDCs basically are organizations exclusively or substantially financed by the government and administered on a contractual basis by a profit-motivated organization (industry) or an educational or other non-profit institution.[7] The FFRDCs are not peculiar to the Department of Defense. In fact, of the 34 organizations now designated as FFRDCs, the Department of Defense has sponsorship of only six. Sponsorship of the others includes the Department of Energy with 20, National Science Foundation with six, National Institute of Health with one, and NASA with one. The six Department sponsored FFRDCs are:[8]

R&D Laboratory

—Lincoln Laboratory (Air Force)

Study and Analysis Centers

—Center for Naval Analysis (Navy)

■ *Lieutenant Colonel Peterson is a full-time student and doctoral candidate at The George Washington University, Washington, D.C.*

Table 3. Federal Government Involvement

YEAR	AS A % OF ALL NATIONAL SOURCES OF R&D FUNDS	AS A % OF ALL NATIONAL PERFORMERS OF R&D
1960	65	13
1965	65	15
1970	57	16
1975	51	15
1980	47	12
1985	47	12

Source: **Adapted from National Science Board,** *Science Indicators: The 1985 Report,* **(Appendix Tables 2-3 and 2-5), pp. 218 and 220.**

Table 4. DOD RDT&E Fund Recipients (As a Percent of Total DOD RDT&E Funds (by TOA))

RECIPIENT	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87*
INDUSTRY	67.3	68.0	68.3	70.6	71.1	71.7	71.3
IN-HOUSE	26.6	26.1	24.5	23.3	22.9	22.4	22.8
Federally Funded R&D Centers (FFRDCs)	2.4	2.2	2.4	2.3	2.3	2.2	2.2
UNIVERSITIES	3.7	3.7	3.9	3.8	3.7	3.8	3.7

***Estimated**

Source: **Department of Defense,** *The Fiscal Year Department of Defense Program for Research and Development* **(Washington, D.C.: GPO, for appropriate year.**

—Institute for Defense Analyses (OSD)

—Project Air Force-Rand Corporation (Air Force)

System Engineering/System Integration Centers

—Aerospace Corporation (Air Force)

—CCCI Division of MITRE Corporation (Air Force)

As shown in Table 4, most (about 70 percent) of Department of Defense R&D funds are spent on work performed by industry. Actually, more than this amount actually flows to industry, since industry would also share in a part of the R&D funds spent for work done by other recipients listed in Table 4.

The defense RDT&E appropriation consistently accounts for about 10 percent of the total defense budget. The defense R&D funds flowing directly to industry are conveyed primarily by defense contracts to individual firms. During 1960-85, defense R&D contracts, on the average, accounted for 15.5 percent of all Department of Defense prime contract awards. During this 25-year period, defense R&D contracts, as a share of all DOD contracts, ranged from a low of 10.3 in fiscal year 1981 to a high of 25.6 in fiscal year 1960.[9]

From the data in Table 5 comparisons can be made between private firms as defense R&D contraqctors and these same firms as merely private industrial firms engaged in corporate (civilian) research and development efforts.

Data in Table 5 suggest that defense sponsored R&D as a percentage of sales is significantly higher than company sponsored R&D in almost every case. Also, there appears to be a wide spread in the range of defense R&D as a percentage of sales; yet, the range of company sponsored R&D as a percentage of sales is more consistent. Perhaps this suggests that firms plan company sponsored R&D at predictable levels, while the levels of defense R&D performed are more likely a function of chance, based upon winning defense contracts.

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From the data in Table 5 comparisons can be made between private firms as defense R&D contractors and these same firms as merely private industrial firms engaged in corporate (civilian) research and development efforts.

Data in Table 5 suggest that defense sponsored R&D as a percentage of sales is significantly higher than company sponsored R&D in almost every case. Also, there appears to be a wide spread in the range of defense R&D as a percentage of sales; yet, the range of company sponsored R&D as a percentage of sales is more consistent. Perhaps this suggests that firms plan company sponsored R&D at predictable levels, while the levels of defense R&D performed are more likely a function of chance, based upon winning defense contracts.

In summary, while government funding for R&D has declined during the past 25 years, the government role as a performer of R&D on a national scale has remained relatively constant. The government role as a performer of defense R&D is more significant than its role as performer of R&D in general. This is likely due to the large federal investment in defense related R&D facilities and the need to exercise more direct control of the actual nature and direction of the R&D efforts. It is

Table 5. Comparison of Selected Firm's R&D Efforts
(Dollars in Millions)

COMPANY	1983 TOTAL SALES	DEFENSE R&D			COMPANY SPONSORED R&D		
		DOD R&D AWARD RANK	DOD TOTAL DOLLARS AWARDS	R&D % OF TOTAL SALES	CIVILIAN INDUSTRY & R&D RANK	FIRM'S R&E DOLLAR EXPENSE	R&D % OF TOTAL SALES
Boeing	$11,129	1	$1,703	15.3	Aerospace #2	$429	3.9
Rockwell Int'l	8,098	2	1,172	14.5	Conglomerate #2	254	3.1
Martin Marietta	3,899	3	1,049	26.9	Conglomerate #6	95	2.4
T R W	5,493	4	669	12.2	Conglomerate #4	133	2.4
McDonnell Douglas	8,111	5	647	8.0	Aerospace #3	301	3.7
G.E.	26,797	6	645	2.4	Electrical #1	919	3.4
General Dynamics	7,146	7	644	9.0	Aerospace #4	156	2.2
Hughes	"no data" →	8					
Lockheed	6,490	9	509	7.8	Aerospace #5	284	4.4
United Technologies	14,669	10	339	2.3	Aerospace #1	971	6.6
					All—Industry Composite	39	2.6

Source: **"R&D Scoreboard: 1983,"** *Business Week,* **July 9, 1984, pp. 65-78, and** *500 Contractors Receiving the Largest Dollar Volume of Prime Contract Awards for RDT&E-Fiscal Year 1983* **(P02), (Washington, D.C.: GPO, 1984).**

unlikely that the market would independently support the full range of defense related R&D needs.

Character of R&D Work

The character of R&D work relates to the nature of the effort being conducted; i.e., basic research, applied research or development. Table 6 provides a summary of national R&D spending by character of work for selected years since 1960. As you see, trends for respective shares for each individual form of R&D have remained constant during the entire period.

The character of research and development relates to the nature of effort being conducted—basic research, applied research or development.

Table 6 shows that about two thirds of national R&D expenditures are focused on development, while about a fifth of the national total is spent on applied research. Basic research, although it has gained during the past 25 years, receives about 13 percent of the total national R&D expenditures annually.

Table 7 summarizes three categories of R&D mentioned above and source of funds for each category. You can see that during the period covered by the data there have been significant shifts in funding support for each of these three R&D categories.

Table 6. National R&D Expenditures by Character of Work

CHARACTER OF WORK	1960	1976	1980	1985
Basic Research	8.9	12.8	12.9	12.5
Applied Research	22.3	23.2	22.4	21.5
Development	68.8	64.1	64.6	66.0
		100%	100%	100%

*Totals may not add to 100 percent due to rounding.

Source: National Science Board, *Science Indicators - The 1985 Report*, p. 37. Specific data for individual years can be found in Appendix Tables 2-3 and 2-6, pp. 218 and 221.

Changes in government support for basic research have not been as pronounced as changes in government support for applied research and development. Government funding support in the latter cases has decreased sharply. Since neither universities or "all other" funding sources have a significant funding role in applied research or in development, it has been industry that has taken up the slack resulting from the decrease in federal funding for these two forms of R&D. It should be noted that during 1960-85 there was more than a threefold increase in national R&D expenditures for basic research, as measured in constant 1972 dollars. The increase for applied research and for development expenditures, as measured in constant 1972 dollars during the same period, was more than twofold for each category.

Profiles of national spending for the three forms of R&D shown in Table 7 are significantly different when compared to spending for defense R&D. Table 8 illustrates this point. Note that Table 8 data pertain to contract award data and that not all defense R&D is accounted for via defense contract. Table 4 shows approximately 70 percent of Department of Defense R&D funds flow to industry via contract.

While the expenditure for basic research has been about 13 percent of the national total (Table 7), basic research accounts for about 4-7 percent of defense R&D dollars awarded by contract (Table 8). Applied research and development have accounted for about 8-10 percent and 83-88 percent, respectively, of defense R&D contract awards but only about 22 percent and 66 percent, respectively, in terms of national R&D expenditures.

In defense research and development, engineering development consistently receives the majority of Department of Defense R&D procurement funds; between 40-55 percent of the total. This form of research and development is on the extreme outer boundary of the "R&D scale," as measured in terms of technological innovation. Basic research and the exploratory development constitute "early" stages of defense research and development. These stages are followed by the "development" categories of R&D, where the bulk of defense R&D funds are spent. When viewed in the aggregate, the Department of Defense R&D budget is essentially a development budget. In essence, "research" is a small portion of the defense R&D effort.

Regardless of the general emphasis taken in the government in terms of what R&D form is in vogue, it seems unlikely that emphasis in defense R&D will change significantly. This is true in large measure because of the nature of the defense industry and the recurring need of the nation for the production of advanced weapon systems. With few exceptions, such as the recent research efforts associated with the Strategic Defense Initiative, defense R&D emphasis has been to field quickly a new system because of an existing or perceived threat. To support this situation, the defense industry has revolved around production of major systems rather than associated research efforts. Indeed, it is development and production that is the "cash cow," not basic or applied research. Perhaps it is in this sense that defense R&D and civilian R&D are most alike.

Conclusion

This article highlights differences between civilian and defense research and development expenditures. We see how trends in data for R&D on a national level usually differ from trends in similar data relating specifically to defense R&D. The more aggregated defense R&D data becomes, however, the less obvious become differences between it and R&D in the private sector.

More clearly defined, structured and planned defense research and development is contrasted with civilian research and development which generally is uncoordinated and often duplicated within respective industries. General absence of free-market forces in the monopsony of defense R&D is mentioned; however, the case of unrecovered IR&D shows the civilian industry will invest in defense R&D. Note that even given such limited investment by the civilian sector in defense R&D, the eventual issue of profitability will be built around a risk equation, which differs from the concept of risk involving an investment in civilian R&D. Defense R&D contracts frequently are awarded on the basis of some form of cost reimbursement, whereby the contractor is reimbursed costs and usually assured some degree of profit. This "risk-free" scenario is difficult to compare in the civilian sector in terms of research and development investment.

Defense R&D, as a share of total national R&D expenditures, has declined significantly since 1960; i.e., from a 1960 high of 52 percent to a level of 30 percent in 1985. On the other hand, defense R&D, as a share of federally funded R&D, has risen from low levels experienced in the 1970s (about 50 percent annually) to current levels of about 65 percent. This distinction is widely misunderstood. Frequently the increase in defense R&D, as a share of federally funded R&D, is assumed to

be an increase in defense R&D relative to the total U.S. national expenditures for R&D.

Today there is about an even split between federal government and private sector funding support for research and development. The private sector's proportion of this commitment has grown significantly since 1960, when it accounted for 35 percent of the total national expenditure for R&D. The private sector performs most R&D efforts (about 73 percent). The government role as an R&D performer is limited and has remained rather constant during the past 25 years, especially in defense R&D. This consistency as a performer of R&D has been witnessed in view of a significant loss of share in terms of government funding support for national R&D efforts.

The short-term, clearly defined "payoffs" may drive defense and civilian research and development just as they seem to have driven the general economy of the United States.

It appears the nature of defense R&D and civilian R&D are significantly different in each of the three areas investigated; perhaps they are most similar in that most of their efforts and funding are targeted at developmental work. This may be explained in terms of the relationship between the "payoff" for R&D work and the character of R&D work itself. In other words, there is little relationship between a specific "payoff" and basic research, while development efforts clearly have specific goals and results of developmental work can be measured against such goals. The short-term, clearly defined "payoffs" may drive defense and civilian research and development just as they seem to have driven the general economy of the United States.

Table 7. National Expenditures for R&D by Character of Work And Source of Funds
(All figures are in percentages)

SOURCE:	1960	1976	1980	1985
BASIC RESEARCH				
Federal Government	60	69	69	66
Industry	29	15	16	19
Universities	6	10	10	10
All Others	5	6	5	5
	100%	100%	100%	100%
APPLIED RESEARCH				
Federal Government	56	50	47	40
Industry	41	44	48	55
Universities	2	3	3	3
All Others	1	3	2	2
	100%	100%	100%	100%
DEVELOPMENT				
Federal Government	68	48	43	45
Industry	32	52	57	55
Universities	-	-	-	-
All Others	-	-	-	-
	100%	100%	100%	100%

*Individual percentages are rounded.

Source: Adapted from National Science Board, *Science Indicators: The 1985 Report*, Appendix Tables 2-7 thru 2-9, pp. 222-225.

Table 8. DOD RDT&E Prime Contract Awards More Than $25,000
(Percentage of Total by Character of Work)

Fiscal Year	Engineering Development	Opn. Systems Dev.	Advanced Dev.	Exploratory Development	Research	Mgt. & Spt.
1978	51.2	7.9	20.4	9.0	3.7	7.9
1979	43.2	12.3	18.6	8.5	4.5	13.0
1980	42.1	11.6	19.4	9.2	6.8	10.9
1981	45.9	20.3	12.4	10.3	6.6	4.5
1982	54.9	17.6	11.7	8.6	4.6	2.5
1983	53.0	17.4	14.9	7.7	4.7	2.2
1984	55.7	16.0	13.9	6.8	5.2	2.5
1985	43.8	20.5	17.2	9.1	6.0	3.4

*Totals may not add to 100% due to rounding.

Key to Character of Work
Basic Research = Research
Applied Research = Exploratory Development
Development = Advanced Development
+
Engineering Development
+
Management and Support
+
Operational Systems Development

Source: Department of Defense, Washington Headquarters Service, *500 Contractors Receiving The Largest Dollar Volume Of Prime Contract Awards For RDT&E*, Publication P02 for applicable year, (Washington, D.C.: U.S. Government Printing Office).

It is safe to say that the most fundamental difference between defense and civilian R&D rests in the notion of defense as a "public good." Since the free market will not likely support ventures not returning profit, government support (funding) is necessary. The private sector will actively engage in the performance of defense research and development work since profit is present in this effort. Generally, the private sector will seldom participate in defense research and development as a source of funds, which would be investing in something with a profit potential limited to activity in a monopsonistic market. Data reviewed seem clearly to support this notion. ■

Endnotes

1. National Science Board, *Science Indicators, The 1985 Report* (Washington, D.C.: GPO, 1985), p. 43.

2. Ibid.

3. Kosta Tsipis and Penny Janeway, *Review of U.S. Military Research and Development: 1984* (Washington, D.C.: Pergamon Brassey's International Defense Publishers, 1984), p. 9.

4. Adapted from National Science Board, *Science Indicators: The 1985 Report* (Washington, D.C.: GPO, 1985), p. 231.

5. Ibid., p. 35.

6. Kosta Tsipis and Sheena Phillips, *Annual Review of Military Research and Development: 1982* (New York: Praeger Publishers, 1983), p. 17.

7. Ralph Sanders, *Defense Research and Development* (Washington, D.C.: Industrial College of the Armed Forces, 1968), p. 82.

8. Office of Management and Budget, Office of Federal Procurement Policy, "Federally Funded Research and Development Centers," OFPP Policy Letter 84-1, *Federal Register* 49, No. 71, 11 April 1984, 14462.

9. Department of Defense, Washington Headquarters Service, *Prime Contract Awards*, (PO3), (Washington, D.C.: GPO, appropriate years).

INSIDE DSMC

People on the Move


Gamboa


Langston


Lerer


Payne


Roschitz

Major Donna G. Gamboa, USA, is Director of the Resource Management Directorate. She holds a B.A. degree in physical education from the California State University of Los Angeles. Previous assignments include Program Analyst at Headquarters, Intelligence and Security Command, Arlington, Va., and Resource Manager at USA Special Security Group, Arlington.

Joann H. Langston, Holder, Army Chair, DSMC Executive Institute, was the Director, Study Program Management Agency, Office of the Deputy Under Secretary of the Army (Operations Research). She holds a B.A. degree in mathematics from the College of New Rochelle, N.Y., and a J.D. degree from the University of Maryland Law School. Ms. Langston has completed executive management programs at the Harvard University J.F. Kennedy School, the Dartmouth Amos Tuck School, and the Federal Executive Institute.

Dr. Lawrence Lerer, a Professor of education in the Department of Research and Information, was an independent consultant before joining DSMC in November 1987. He holds a B.A. degree from Brooklyn College, an M.A. degree from Columbia University, and an Ed.D. degree from Harvard University.

Sharon A. Payne is Network Administrator/Systems Programmer, Automation Management Directorate. She came to DSMC from The Command and Control Support Agency, the Pentagon. She holds an A.A. degree from Charles County Community College, and a B.A. degree from the University of Maryland.

Patricia A. Roschitz is Systems Administrator in the Automation Management Directorate. During her last assignment at the Army Personnel Center, Civilian Information Systems Directorate, she was selected to be an intern in the automated data processing field.

Gains

Staff Sergeant Gayle A. Breer, USA, Department of College Operations and Services. Her last assignment was in the Office of the Assistant Secretary of Defense, Production and Logistics, the Pentagon.

Losses

Staff Sergeant Joseph Pachecho, USAF, Printing and Duplicating Division, to Brussiun City, the Netherlands.

Major Jim Harris, USAF, Director, Automation Management Directorate, retired.

Dr. C.E. Bergman, Air Force Chair, Executive Institute, retired.

Ronald L. Baker, Research Staff, to U.S. Marine Corps Research, Development and Acquisition Command, Quantico, Va.

In Memoriam

Henry M. Barrbera, graduate of PMC 79-2, died October 23, 1987. He was employed by Sanders Associates, Inc., as Director of the AN/USM 464 Production Program. Mr. Barrbera was 43.

UPDATE

MOBILIZATION AND INDUSTRIAL PREPAREDNESS PLANNING

Albert M. Bottoms

As you complete this phase of your education in defense systems acquisition management, you are aware there are subjects we have been unable to cover or to cover in depth—that are vital competencies for a program manager. Mobilization and Industrial Preparedness Planning is one. I want to highlight a few topics you may encounter in the near future and to offer personal assistance.

The Defense Systems Management College has commissioned the preparation of an *Industrial Preparedness Planning Handbook for Program Managers*; when completed in 1988, it will be a part of our handbook series. This handbook will show by example how the program management office meets responsibilities at each acquisition milestone. Given the emphasis that the new Defense Acquisition Executive is placing on industrial preparedness planning, and given the new initiatives in the processes called graduated industrial response—a conditioned mobilization response to ambiguous warning—I am certain that program managers will be held accountable for industrial preparedness to a greater degree than in the recent past. There are important resource implications to direct acquisition costs and to resources the program manager must have.

Henry Alberts of the Technical Management Department introduced you to the tiered structure of defense industry. Ask yourselves how well you understand the tiered structure of specific industry sectors. Where are piece-parts, components, or subassemblies procured? Of necessity, our discussions at DSMC, and much of the effort in a program office, focus on the prime or first tier. The pacing steps in foreign sourcing or in sole- or limited-suppliers usually occur in lower tiers. Negative impacts of competition, pricing, profit, etc., policies often are passed to the lower-tier suppliers by the prime. In this way, do we gut the industrial base unintentionally but effectively? You, as responsible members of a program office, must become explicitly aware of the economic dynamics of the industrial tiers supporting your program. This is applied microeconomics.

The discussions at DSMC of the acquisition cycle have been in the contexts of peacetime acquisition. The Joint Chiefs of Staff (JCS) initiatives (with OSD [Policy]) have led to definition of the Theater CINCs Critical Item List (CIL). The Joint Industrial Preparedness Planning Process (JIMPP) is an approach to prioritizing procurement of materiel deemed essential to warfighting objectives. In this arena, we encounter competing demands of force sustainability and force expansion. Many of you will become aware of the Production Base Analysis programs of the military services and of the more ambitious Army Functional Area Analyses (FAA). These analyses represent current best efforts to obtain estimates of delivery rates under emergency or mobilization conditions. Many of you are familiar with D-to-P planning and with the "surge" processes designed to improve near-term warfighting sustainability.

Soon, you will be hearing about DOD Industrial Base Initiatives in conjunction with industry. You will hear about pilot programs sponsored by the Federal Emergency Management Agency and the Department of Commerce in flexible manufacturing; a program for emergency production of ship spares, RAMP, that is jointly sponsored by the Navy and the Department of Commerce/Bureau of Standards; and research into manufacturing technology applied to electronics and avionics taking place at the Naval Weapons Center, China Lake. These projects are harbingers of much to come as we solidify advances in Computer Aided Design and Manufacture (CADCAM). Such approaches, if carried through to implementation, will change slopes of the standard D-to-P Curves.

You should be aware that the U.S. defense industrial base includes Canada. The health of the Canadian sub-tier suppliers is vital to overall health of the base. Procurements from Canadian firms are not inhibited by "Buy America" provisions. In other words, Canadian firms should compete on equal footing with American suppliers. This is not well understood. Think also of the curious dichotomy that arises from NATO interoperability and co-production policies. Foreign sourcing entails the risk of foreign dependency. It is a program management office responsibility to identify emergent risks at milestone reviews.

A hallmark of graduated industrial response is recognition of what peacetime constraints can be eased or lifted. This process is in its infancy; however, you will soon encounter provisions for examining OSHA or other restrictive rules, relaxation of inhibiting labor regulations, the concept of "mobilization" designs, component substitution or even functional substitution of one weapons system for another.

Under normal or peacetime procurement conditions, we depend upon

■ *Mr. Bottoms, Navy Chair at DSMC, provided this update to students of PMC 87-2 and the DSMC Faculty. This area is fast moving due to events like the DOD Serial Exercises and the Naval War College Global War Games.*

market forces to shape acquisition and bidding strategies. By definition, mobilization is intervention by the government in all aspects of the economy, labor, fiscal policy, materials allocation, energy allocation, production priorities, etc. Such an environment is vastly different from that envisioned in your DSMC or work experiences. It is incumbent upon you to ponder those differences and be prepared to respond should the need arise.

Thanks to the support and encourgement of General C. P. Cabell, Jr., DSMC enjoys a pre-eminent place in mobilization and industrial preparedness planning. Several faculty members—David Acker, Henry Alberts, Dr. Franz Frisch, Forrest Gale, LTC Sam Young, USA, LTC Robert Angeli, USA, and myself—are active participants in mobilization forums. I chair the War Resources Working Group of the Global War Game at the Naval War College. This senior interagency group is patterned on the War Mobilization Board of World War II and is examining issues arising in Total Mobilization and in resource allocation between the civil and the military war economics. Dr. Frisch is leading a panel of the War Resources Working Group that is investigating the various econometric models that are used in mobilization planning. Through this broad-based applied research and through the medium of the *Program Manager* magazine we shall attempt to keep you informed of developments in mobilization and industrial preparedness planning as they may affect you as program managers. Please call any of us if we can help.

I have background material on mobilization and industrial preparedness that I have used in my elective course on that subject. You are welcome to it. I hope this has alerted you to opportunities and to breaking events. Remember, every time you hear the words industrial revitalization or renewal of America's industrial competitive edge, you are dealing with a plus for the defense industrial base; every time a product line goes offshore, you are dealing with a minus.

General George Marshall said, "In peace time there is all the time in the world and no money; in war time there is all the money in the world and no time."■

In Watertown: Nuclear Magnetic Resonance Ongoing at MTL

At the U.S. Army Materials Technology Laboratory (MTL), Watertown, Mass., understanding structure of materials precedes their selection for military systems. With increased emphasis on the importance of ceramics, polymers, and other chemical compounds as basic materials for U.S. defense, scientists are turning to MTL state-of-the-art equipment to determine which materials will withstand the challenge of protecting U.S. personnel on the battlefield.

A new and in-depth means of studying properties of organic compounds is being conducted in the MTL Materials Characterization Division. Dr. Louis Carreiro, research chemist, and Dr. Paul Sagalyn, research physicist, determine the structure of these compounds by using the Nuclear Magnetic Resonance Spectrometer, a high strength, high resolution, superconducting magnet.

"Understanding how compounds are 'built' and predicting how to combine them to form new materials," says Carreiro, "can determine how effective they will be in new applications."

The experiment is based on radio frequency transitions between energy states of magnetic nuclei placed in a magnetic field. Each nucleus experiences a magnetic field strength modified by its chemical environment. Purpose of the spectrometer is to measure distribution of magnetic fields of a sample to determine its molecular structure.

The Army Materials Technology Laboratory manages and conducts Army materials research and development program as designated by the U.S. Army Materiel Command, Alexandria, Va., and the U.S. Army Laboratory Command, Adelphi, Md. In addressing Army materiel needs, MTL is the lead laboratory in structural integrity testing, corrosion prevention and control, materials, materials testing technology, solid mechanics, lightweight armor, and manufacturing testing technology

Carreiro and Sagalyn are concentrating on supporting MTL's three laboratories—organic materials, metals and ceramics, and mechanics and structural integrity. Eventually, NMR is expected to become an integral part of the M1 tank track pad program, as different blends of rubber are analyzed for their composition. Scientists can look at the NMR spectrum, verify structure, and see where degradation is taking place.

The MTL will extend efforts to include NMR imaging, a process whereby materials can be scanned to detect flaws. Until now, NMR technology has been applied mainly to petroleum and pharmaceutical industries. Carreiro and Sagalyn look forward to making the military user of this new technology by supporting MTL in-house laboratories, and agencies and commands throughout the Department of Defense.*(Hilary J. Winiger, MTL Public Affairs Specialist)*■

$185 Million Torpedo Order by Navy

The GM Hughes Electronics subsidiary, Hughes Aircraft Company, has been awarded a $184,950,000 contract to continue initial production of the Advanced Capability (ADCAP) Mk 48 torpedo.

Hughes will deliver an additional 123 ADCAP torpedoes, plus items for testing and support, to the Naval Sea System Command. The contract follows a $98 million award in September for work on an earlier phase of the current production effort.

Advanced technologies will enable the submarine-launched ADCAP torpedo to run faster, deeper and farther in pursuit of targets than the standard Mk 48 torpedo it replaces. The company's Ground Systems Group is prime contractor and system integrator for the ADCAP torpedo.■

The People's Republic of China

An Awakening Giant

Article and photographs
by
David D. Acker

Contact with foreign commercialism has taught China that it cannot run a closed-door economy in the modern world. To modernize and to become prosperous, China must export, especially consumer goods. Accordingly, the Chinese have rolled up a large section of its bamboo curtain and declared itself open to the outside world. Signs in cities invite foreign investors to enter and conduct serious business.

COMMERCE

Free-Market Retailing

The initiation of the Four Modernizations (discussed previously) caused profound changes in every sector of the Chinese economy. A fundamental reorganization of the production of all goods and services took place. The retail distribution of consumer goods was changed to meet the priorities set forth by Zhou Enlai and refined by Deng Xiaoping.

Prior to the Four Modernizations, retail distribution was carried out by state-owned stores. The merchandise was manufactured by state-owned factories and the food was grown on state-owned communes. All goods were distributed through state-owned middlemen. The prices were established by the government and they did not reflect the real costs of production or distribution. Under this system, there were no incentives to produce and distribute efficiently. In this merchandise-short, labor-rich economy, the primary goal was equity.

Near the end of the 1970s, the level of production and distribution of some goods and agricultural products reached a level

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This is the third of a three-part special report on the People's Republic of China today. The first appeared in the November/December 1987 issue of **Program Manager** *and the second part in the January/February 1988 issue.*

at which the government no longer had to make equity the primary consideration. Thus, in December 1978, the government announced the restoration of free markets and plots for private farming. Production in excess of the state quota could be sold to consumers without passing through the state distribution system. This stimulated growth in production.

China's agricultural reforms are working and they have improved the lives of the Chinese people. In the last 9 years, farmers' incomes increased more then they did in the first 30 years of communist rule. Farm output rose dramatically. For example, the output of grain rose an average of 4 percent a year from 1978 to 1986, although yields fell slightly in 1985 and 1986. Instead of being a large importer of grain, China is now a net exporter. The output of cotton, another product of China, has increased an average of 15 percent a year since 1978.

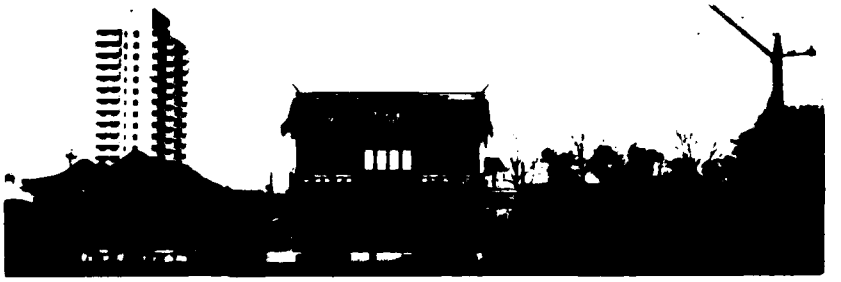
Each family receives a share of the crops it grows, and a share of profits from the sale of its surplus crops. Further, each farm family owns a two- or three-room house, which is supplied with electricity, and the plot that surrounds the house. On this plot, the family can grow vegetables and raise chickens or pigs for its use.

The older houses were made of mud bricks and had a tile or a straw roof; the new houses are made of clay bricks or stone and have tile roofs. In cities, new apartments are being constructed for workers in business, industry, and government.

At the outset, the argicultural reforms resulted in greatly increased production; however, China is now pampering its urban population by keeping food prices in the city lower than the contract prices in the countryside. The government is making up the difference. The subsidy represents the cost of failure of price reform in agriculture. The farmers are becoming rebellious. So, instead of growing rice and wheat, they are growing the more profitable free-market vegetables, and engaging in such "side-line" activities as poultry-raising. The side-line activities are booming and production of staples is beginning to stagnate.

As free-market produce and goods become available, township enterprises are beginning to engage in manufacture and distribution. Today, free-market retailers include both proprietors and collectives.

Tea Plantation.

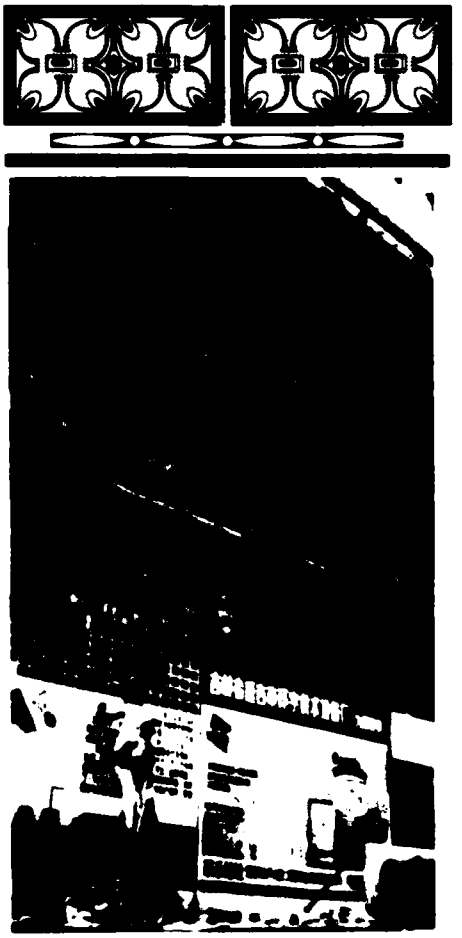


Homes and Apartments.

Between 1980 and 1986, there was more than a 600 percent increase in retail and service shops. Presently, more than 6 million establishments are operating in 60,000 specially designated free-market areas. In spite of growth, free-market retailing is considered a supplement to the state system, not a substitute for it.

The free market has been concentrating on non-essential goods; however, where the government perceives that free-market retailing will stimulate the production and the efficient distribution of essential goods, essential goods are allowed to enter the market, particularly when equity is not a paramount consideration.

The free market has raised some new possibilities relative to the accelerated development of the Chinese economy. The free-market retailing is changing the structure of China's retail distribution and impacting the type and quality of the goods available to citizens. Also, the internal distribution system in China is feeling the effect of free-market retailing. Beyond this, the free-market retailing is fostering new arrangements in currency transactions and new import opportunities. If China is able to mix the state and free-market systems to deliver goods effectively, it can achieve both equity and efficiency.



Construction of office building in Shenyang. Note advertising and use of bamboo for superstructure.

經濟學

ECONOMY

Special Economic Zones

In an attempt to achieve self-sufficiency during the 1960s and early 1970s, China refused foreign loans and investments. Now, under its open-door policy, foreign businesses have been invited to set up shop within its borders. In 1979, the government designated four areas along the eastern seaboard as "special economic zones (SEZ)." In these areas foreign investors can operate using Chinese labor without many of the restrictions that apply elsewhere in China. The SEZs are located in the southern provinces of Guangdong (Shenzhen, Zhuhai, Shantou) and Fujian (Xiamen). See Figure 1.

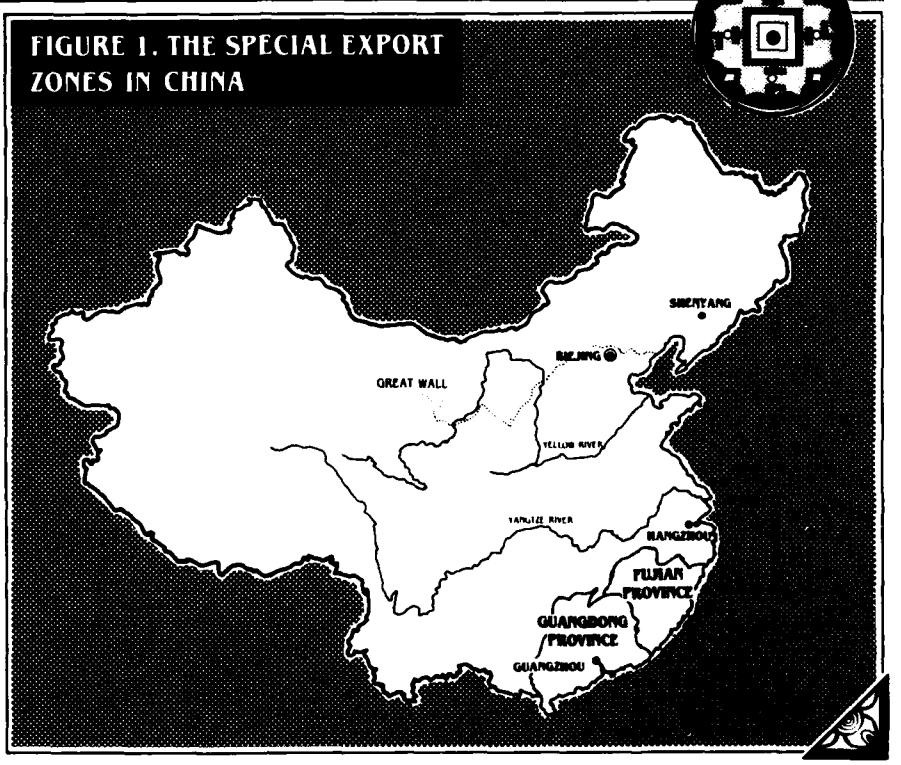


FIGURE 1. THE SPECIAL EXPORT ZONES IN CHINA

Principal features of the SEZs are similar to those found in the free-trade zones in other countries. They include:

—15 percent taxes on corporate earnings and tax holidays

—Cheap land and services (relative to Hong Kong)

—Low labor costs, though higher than in other areas in China

—Greater freedom of labor management than in other areas in China

—No customs duty on re-exported goods

—Lower customs duty on other goods

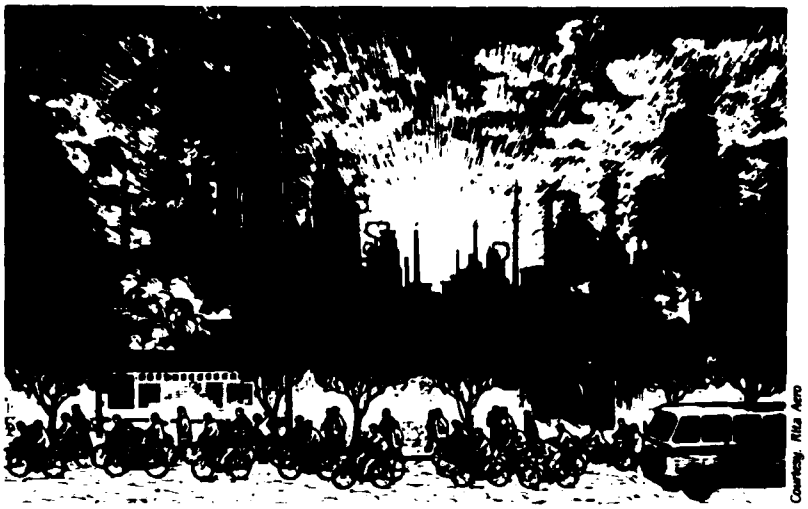
—Simplified entry/exit and other formalities

—Increased access to the internal Chinese markets.

There are some other areas of China in which similar, but more limited, measures are in force. These include Hainan Island, 14 coastal cities along the south and east coasts of China identified in 1984, and three large Open Economic Zones.

Officially, the three goals of the SEZs are (1) to encourage foreign investment and acquisition of advanced technological and managerial skills, (2) to keep in closer touch with developments taking place in the world economy, and (3) make China "whole." Premier Zhao has indicated that growth in employment is not a goal of the SEZs. It appears that the prospects for technology-intensive projects are improving as the SEZ infrastructure is developing. The third goal, which is political, is to bring about the successful reunification with Hong Kong, Macao, and, ultimately, Taiwan.

Although expansion of the SEZ program has been rapid, some serious issues have developed. First, Shenghen, in particular, has been importing goods and reselling them to Chinese customers elsewhere. Second, enterprises in the Zones have been selling much of their production to China itself rather than exporting it. Third, because most of the SEZ industries are relatively low on the technology scale, as well as in the processing and assembly, they sell products having lower value-added than the average Chinese products. Although the SEZs have grown rapidly, their development has been unbalanced.



Courtesy Rita Aero

Modern wood-block print from the Liaoning province, entitled "Sunrise at the Refinery."

做生意

TRADE

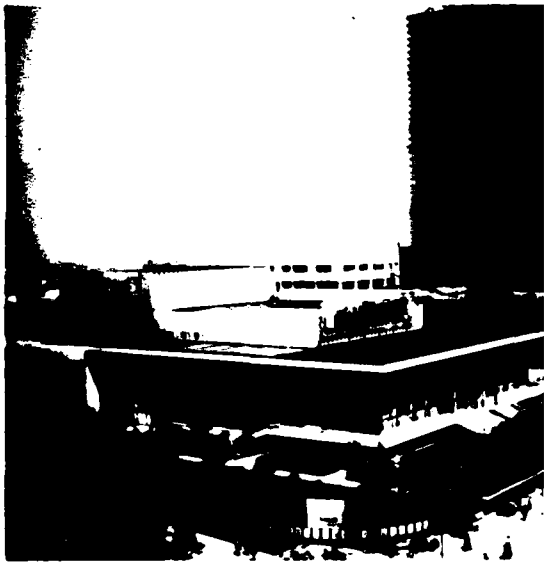
The Chinese Government controls trade (and finance) and, unfortunately, the trade bureaucracy functions with less than consummate speed and efficiency. Trade negotiations are often protracted, expensive, and characterized by uncertainty. However, there is cause for optimism. First, normalization of relations between the United States and China, along with improved ties with the European Economic Community (EEC), have eased some constraints on trade. Second, the recent changes in China's political and social atmosphere, when combined with its development and modernization goals, have resulted in an attitude of pragmatism and a willingness of the Chinese to adopt to current international trade practices. The outlook is favorable for any trader who combines determination and discretion.

The Maoish political slogans are being replaced by colorful advertisements for such items as radios and watches. Much of the foreign investments is being poured into finding oil off the Chinese coast. Many other ventures, including the construction and operation of Western-style hotels, are being conducted with foreign assistance.

The popularity and current success of the reforms in China make any retrenchment highly unlikely in the near future. Deng Xiaoping's visit to the SEZs in 1984 publicized the importance of economic reform, foreign trade, and investment in modernization. The dismantling of the central government's monopoly on foreign trade has spawned new Chinese trading corporations. Ministerial, provincial, city, and private corporations are now able to trade directly with foreign companies.

Until recently, China's foreign trade was handled by Import and Export Corporations under the aegis of the Ministry of Foreign Economic Relations and Trade (MOFERT). These corporations have served as guarantors to foreigners lending to Chinese projects. For example, the China Metallurgical Import and Export Corporation was the guarantor for a multi-million dollar loan by foreign banks to an iron and steel mill. The loan will let the producer keep hard currency at home, create jobs, enjoy the benefits of technology transfer, and indirectly provide economic benefits for the province. The foreign companies providing the capital are happy because the loan pays for their equipment and they have started a good relationship with the corporation.

The Hangzhou Hotel, a joint venture.



Sign of the times: new construction in Hangz

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FIGURE 2. PERCENT OF VARIOUS COMMODITIES IMPORTED AND EXPORTED BY CHINA.

*FIGURES ARE ROUNDED TO NEAREST PERCENT

COMMODITY	PERCENT OF IMPORT*	PERCENT OF EXPORT*
FOODSTUFFS AND LIVE ANIMALS	22	16
CRUDE MATERIALS	14	32
CHEMICALS	12	6
SEMI-MANUFACTURED GOODS	25	23
MACHINERY AND EQUIPMENT	21	4
MISC MANUFACTURED GOODS	4	18
OTHER	1	0

FIGURE 3. CHINA'S IMPORT/EXPORT HISTORY SINCE 1976

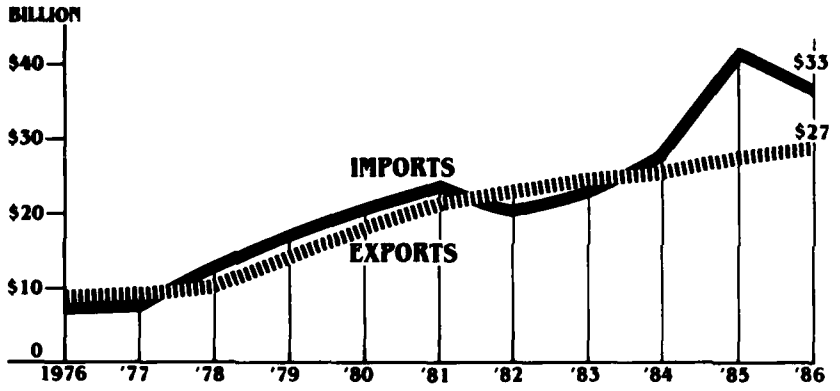


FIGURE 4. CHINA'S EXPORT PATTERN IN 1986

COUNTRY	TRADE VALUE MILLIONS OF U.S. $	PROPORTION OF TOTAL EXPORTS %	CHANGE OVER 1985 %
HONG KONG AND MACAO	9,829.76	31.78	+ 31.9
JAPAN	4,764.02	15.40	— 22.0
UNITED STATES	2,622.05	8.48	+ 12.1
UNITED KINGDOM	1,433.33	4.63	+305.2
SINGAPORE	1,214.92	3.93	— 41.6
SOVIET UNION	1,199.83	3.88	+ 20.5
FEDERAL REPUBLIC OF GERMANY	1,003.24	3.24	+ 36.6
TOTAL	27,000.00	100.00	+ 4.2

COURTESY OF INTERNATIONAL HERALD TRIBUNE 11 12 APRIL 1987

The corporation's power is awesome and its approval of a venture can be paramount to the venture's success.

Recent reforms have nominally broken MOFERT's monopoly, but many trade and investment deals are still passing through a MOFERT-related office for evaluation or implementation.

Several specialized corporations operate under the auspices of a ministry, or the State Council. These corporations include those engaged in agriculture, shipbuilding, transportation, and petrochemicals. Also, there are national-level corporations that sell particular products, such as textiles. These corporations need an initial sanction from MOFERT to trade directly with foreign companies.

The provincial and city trade bureaus have limited power to authorize contracts with foreign companies. These bureaus represent the business interests in these areas, not specific product categories. Many private citizens have set up their own companies, but most of these citizens have no real authority to finalize a deal with a foreign company. Proposals directed to these Chinese companies must eventually be forwarded to a regional, national, or ministerial-level corporation for approval.

China trades with more than 150 countries. The volume of trade with the United States is four times greater than it is with the Soviet Union. The principal commodities imported and exported by China are shown in Figure 2. Unfortunately, the value of China's imports are exceeding the value of its exports (Figure 3).

In 1986, China's exports represented 1.5 percent of the world exports. China's major markets are in Hong Kong and Macao, Japan, United States, United Kingdom, Singapore, Soviet Union, and the Federal Republic of Germany. China's exports, valued at $27 billion (in U.S. dollars), were 4.2 percent higher in 1986 than in 1985. An increase in the domestic demand has limited the increase in the sources of goods available for export.

The major suppliers to China in 1986 were Japan, United States, Hong Kong, Federal Republic of Germany, and Canada. That year, imports dropped 4.6 percent below the 1985 value. This, along with the increase in exports (see Figure 4), is a healthy trend because imports had been exceeding exports since 1983.

運輸

TRANSPORTATION

Farmers on the way to the city.

For hundreds of years the Chinese have relied on simple, traditional means of transportation for short distances. People carried heavy loads fastened to their backs or hanging from poles resting across their shoulders. Carts and wagons have been pulled by people, horses, donkeys, or mules. Boats have been pulled along canals and rivers by animals walking along the bank.

Changes have taken place, but they have not been dramatic. During the past few years, reins on management of China's transportation system have been loosened by the central government in Beijing. Efficiency has been emphasized. Reponsibility and control of the transportation budget has been shifted to the local level.

Roads and Transport Vehicles

In the last 30 years, China has built 560,000 miles of roads. This has not been enough to keep pace with the growth in traffic. The problem has been exacerbated by the fact that the roads have been built where it has been politically, rather than economically, wise to place them.

About 12 percent of China's roads are paved. In contrast, more than 75 percent of the 3.2 million miles of highways in the United States are paved. Obviously, the roads in China need to be extended and improved. Eighty-five percent of the roads are ungraded and cannot cope with heavy, all-weather traffic. In fact, 25 percent of the roads are mere mud tracks.

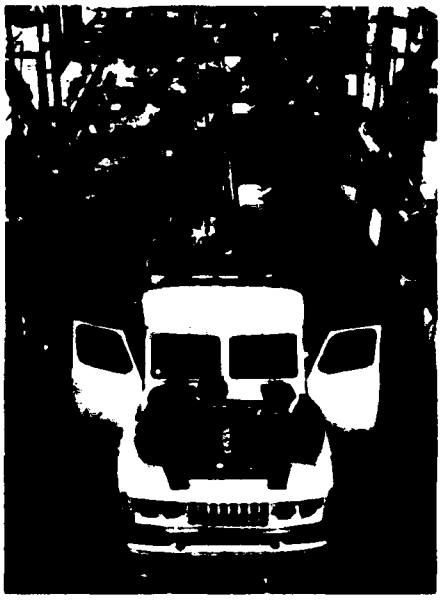
The Chinese farmers are adversely affected by the lack of good roads because roads form the vital link to the marketplace. In rural villages, 64 percent of the roads are not fit for motor vehicles. The Highway Bureau is proposing to solve this problem by providing funds required and encouraging the local residents to construct the roads.

Roads are crucial for transporting produce and goods from inland locations to the ports and from the ports to inland locations. Most of today's roads cannot withstand the weight of trucks needed to transport the heavy freight brought in by cargo ships. Further, most of the roads and the bridges need to be widened for the truck traffic.

The target for 1990 is to build about 1,000 miles of "first class" highways, 6,000 miles of "second class" roads, and 37,000 miles of "rural" roads. This will help to shift much of the freight and short distance passengers from rail, which is overburdened, to road by the end of the seventh Five-Year Plan (1986-1990).

Between now and the end of the century, there will be a growing demand for automobiles to meet private and commercial needs. About 800,000 to 1 million automobiles will be needed by the national government, state-owned enterprises and institutions, urban collectives, and township enterprises. Further, development tourists and taxi services will require about 200,000 to 300,000 motor vehicles of various types.

In the rural areas, there is an increasing need for vans to carry goods. At least one van is needed for each township enterprise. It is estimated that 1.5 to 2 million vans will be needed by the end of the century, including the vans that will be required in the cities.



Courtesy of China Pictorial

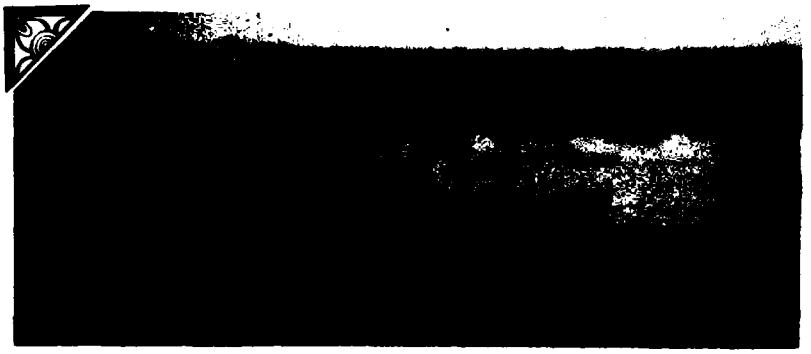
Truck assembly line.

Buses are the principal vehicles for transporting groups of people in the cities. Although there are plans to develop underground railways in some of the big cities, about 800,000 new buses will be needed by the year 2000.

The continuing growth in the volume of highway freight transport signals the need for more trucks, especially heavy-duty trucks. The volume of highway freight transport increased at an average of 15.5 percent annually from 1979 to 1986. It is anticipated that the growth will continue at an annual rate of 8 to 10 percent until the year 2000.

Bridge construction on route to Great Wall, from Beijing. Note lack of mechanical equipment.

Railroad locomotive at crossing in Shenyang. Note bicycles typically outnumber other vehicles.



Traffic on Pearl River.

In order to meet forecasted needs, China will have to raise funds, import advanced technology, and expedite the growth of its automobile, van, bus, railroad, and truck industries.

Railways

Railways are an important part of China's transportation system. Thirty-two thousand miles of track, about one-ninth the miles of track in the United States, link major cities and manufacturing centers of China. Trains transport one billion passengers per year and more than 50 percent of the frieght. The passenger load represents one and a half times the seating capacity in the passenger trains.

Eighty percent of the railways are single track, but many miles of double tracks are being built. By 1990, about 2,500 miles of railroad will be electrified.

Railways are the "arteries of the nation's economy." Industry relies on the railways for transportation of coal to the factories. Although rail mileage had doubled since 1949, passenger volume has increased 800 percent and freight volume 1,900 percent. Construction of new lines is vital; therefore, 6,800 miles of new lines have been included in the current Five Year Plan.

Three-quarters of China's locomotives are steam driven and based on designs that are 40 years old. They are being replaced gradually with diesel and electric trains. The East Germans, Polish, Swedish, and French are the major suppliers of China's rolling stock.

Some of the pressure on the railways is being relieved at no cost. Short distance rail travel is being discouraged by surcharging.

Ports and Waterways

There are 15 major and 180 minor ports in China, but port capacity is not sufficient. The growth of foreign trade has resulted in the ports being swamped. Without sufficient berths, cargo ships often wait several weeks to unload. On any average day, 500 vessels are awaiting entry to the major Chinese ports.

To solve the problem, 13 ports have been identified for major re-development. One hundred and twenty new berths will be added by 1990. These new berths will increase the handling capacity from 300 million to 500 million tons per year.

The Chinese shipbuilding industry is starting to compete internationally.

About 25 percent of China's 100,000 miles of inland waterways can be used by passenger ships and freighters. In addition to rivers like the Yangtze, Yellow, and Pearl, the busy Grand Canal, longest in world and extending more than 1,000 miles from Beijing to Hangzhou, carries both passengers and freight.

A Boeing 747, owned and operated by the Civil Aviation Administration of China (CAAC), being loaded for departure.

Airways

To handle air traffic, the Civil Aviation Administration of China (CAAC) was set up in November 1949 with a fleet of small piston-engined aircraft operating on 12 domestic routes. It carried 10,000 passenters in 1950, and 9 million in 1986. Today, the CAAC is flying to five continents—to 28 cities in 23 countries. On the domestic front, CAAC is flying to more than 80 airports in China and offering about 2,200 departures per week. The CAAC has established business links with 386 foreign airline companies. The current Five Year Plan calls for a 14.5 percent annual growth until 1990. The CAAC plans to improve its level of passenger service. It will provide additional training for the staff at all levels in order to do so.

In 1984, the CAAC began to change its role from an airline to a regulatory body. Since that time, it has been setting up quasi-independent airlines. The new airlines will compete with one another and, hopefully, stimulate efficiency and raise standards. The United China Airlines was the first new airline and is the largest. The new airline was formed as a joint venture with the PLA air force. Shanghai Airlines was the second independent airline to be organized. It was financed by three outside shareholders: the Bank of China, the Jinjiang Association, and the Foreign Trade Association.

Six other major airlines have been formed, namely: China Airlines, which is Beijing-based; China Eastern Airlines, Shanghai-based; China Southern Airways, Guangzhou-based; China Southwest Airways, Chengdu-based; China Northwest Airways, Xian-based; and China Northern Airways, Shenyang-based. There are ten small provincial airlines. Although it appears unlikely that CAAC will relinquish control of aviation for a while, the move toward independent airlines is evidence of a new attitude toward management in China's transportation system.

There are 90 airports available for civilian use including four international airports. Most date back to World War II and need enlargement and/or rebuilding. Only 10 percent of the airports can accommodate Boeing 747s or Tridents.

The CAAC has 164 passenger airplanes. The airplanes being flown by CAAC today include Boeing's 707s, 737s, 747s, 757s, and 767s; McDonnell Douglas' DC-9s, MD-80s, and MD-82s; Great Britian's Tridents and Viscounts; France's Airbus 310s; and Russia's Tu-154s. By the end of 1987, CAAC expected to have 13 more passenger airplanes in operation. It plans to continue buying aircraft for several decades, but it would like foreign support in the development of an aircraft industry.

Today, China is successfully building and selling aircraft parts to the West. China Aero-Technology Import and Export Corporation (CATIC) has produced more than 800 parts, such as ailerons, stabilizers, hatches, and water tanks. These parts are being sold to companies in the United States, Great Britain, the Federal Republic of Germany, Canada, France, and Italy. In 1985, contracts for these parts reached $25 million.

交通

COMMUNICATION

The oldest written record of Chinese history dates back to the **Shang** dynasty, 16th century to 1100 B.C. These records consist of inscriptions inside bronze vessels and notations scratched on thousands of turtle shells and animal bones. About 100 B.C., Suma Ch'ien wrote the first major history of China.

In modern China, most communication is controlled by the government. The government controls what is printed in newspapers and magazines, and what is transmitted by radio and television.

The first newspapers published in China during the early 700s predated the European newspapers by 800 years. Today, the New China News Agency publishes the newpapers. It is the sole source of news for all media. The Central Broadcasting Bureau owns and operates all radio and television stations. The Bureau publishes and distributes all books. These agencies work closely with the Ministry of Education and the Ministry of Culture. The New China

China Reconstructs and *Beijing Review*.

News Agency and the Central Broadcasting Bureau are under direct control of the Politburo of the Central Committee of the CCP.

The most important national newspaper is the *Peoples Daily*, an official organ of the Central Committee. Another national newspaper is the *People's Liberation Army Daily*, which prints news items of interest to the armed forces. An English language newspaper, *China Daily*, and the periodicals, *China Reconstructs* and *Beijing Review*, are distributed widely to local and foreign readers.

A general review of the media in China today reveals some interesting facts. There are 305 newspapers, 633 magazines, 115 radio stations, 50 million radio receivers, 57 television stations, and more than 15 million television receivers. Additionally, there are three standard international satellite ground stations in operation.

There are countless mineographed and handwritten news-sheets posted on walls and bulletin boards in China. The Chinese constitution guarantees that the people have a right to express their political opinions on posters; however, posters placed on walls are quickly removed by governmental authorities when they express what authorities consider to be unacceptable opinions.

The people depend on the postal system for personal communication.

結論 (ケツロン)

CONCLUSION

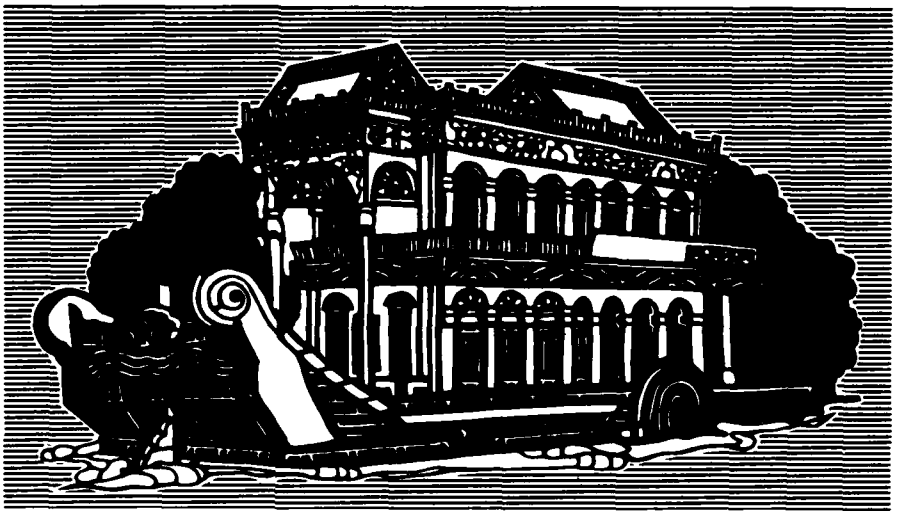
This is the way I see it. China is ruled by the Chinese Communist Party. The CCP was born in the wake of foreign invasion and collapse of the traditional social order. It developed in the throes of civil strife.

Today, the winds of change are evident everywhere. Change is probably the most constant aspect of China's image today. Although there have been pauses and reverses, change has been steady in the post—Mao Zedong era. Beginning in 1978, Deng Xiaoping, the elderly stateman, brought China the best of technology and management from the capitalistic countries. He reformed the educational system and allowed Chinese students to study abroad. He broke up the communes, gave bonuses to workers, and created a new consumerism. He gave significant latitude and decision-making power to work units; i.e., State-owned enterprises, collectives, households, and individuals.

Although the Chinese government has tried to increase the efficienty of industry, there have been three major obstacles. First, the prices of goods have generally failed to reflect scarcity, production costs, and quality. Second, the critical shortage of energy and the deficiency in transportation have held back the economy. Third, there have not been enough talented and well-trained people who can make the new reforms work. For the most part, leaders of industry have not been able to increase efficiency and make a profit.

Deng recognized the need to bring younger people into the government. In September 1985, 131 top CCP leaders, mostly those who were aging, were encouraged to resign to give way to younger leaders. More than 900,000 party and government officials were forcefully retired in China since 1979. Further, Deng implemented the same policy in the military officer corps. Many of the elderly peasant generals were forced to retire in favor of younger men with more engineering education and technical training.

Underlying industrial reform, which is more complex in its implementation than rural reform, is the rethinking of the concepts of commodity and the law of value. The Great Leap Forward and the subsequent Cultural Revolution were disasters for the Chinese people. Under Deng the emphasis was not on transformation of human nature; rather, on materialistic goals. In China's search for modernization, a dichotomy exists between the quest for alien scientific ideals and social morality. When Chinese people pause to reflect on the national catastrophe—the Cultural Revolution—they may wonder if the winds will change again.



The Stone Ship at winter (Summer Palace at Beijing).

Courtesy, Rita Aero

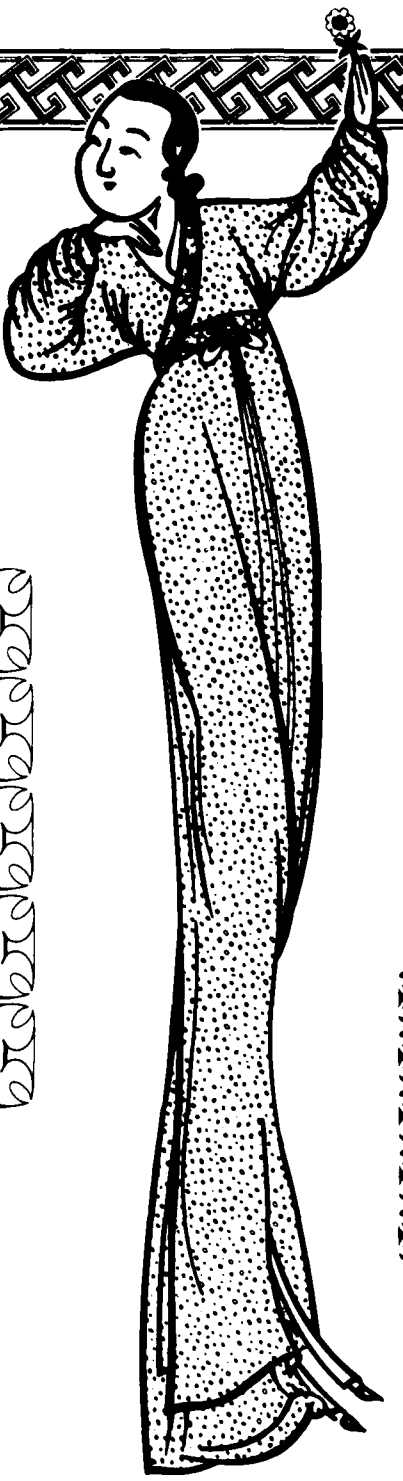
To me, the astonishing thing about the economic, cultural, and social changes in China is that they are occurring in a country where the political power is still monopolized by the CCP. The right of the people to choose their destiny, as well as free political and artistic expression, were an anathema to Deng and they are to the CCP as well. It is surprising that the CCP has been willing to admit that serious errors have been made and to oversee fundamental reforms.

Many of the people prospering today are the people who suffered under Mao. In the cities, people with a higher education, business skills, and foreign connections are doing well. In the countryside, a group of relatively wealthy peasants seems to be emerging.

As might be expected, the reforms in China have caused some problems. The improved standard of living is bringing about a building boom in peasant housing. The housing is taking up scarce farmland and complicating efforts to increase food production. Second, the removal of farms from collective management and the return to the family farm is making it more difficult to implement the birth control campaign. The family-farm policy is making the one-child-per-family rule unpopular because peasants want larger families to help them produce more on their family plots. Finally, urban economic reforms have caused inflation, corruption, and some moral decay.

What changed under Deng? In economic theory, the central thrust was a repudiation of Mao's vision of a highly collectivized egalitarian society in favor of a mixed economy that places considerable reliance on market forces and gives significant latitude and decision-making power to work units. Deng's pragmatism was a dominate force, but the winds can change again. China's economy is still centrally planned and centrally controlled, but a considerable degree of local initiative is being encouraged in most sectors. Today, an opportunity exists in China for engineers, scientists, teachers, doctors, and many other professionals who wish to serve the best interests of mankind.

XXX



Sheraton's Great Wall Hotel in Beijing, a joint Chinese/American venture.

What happens to Deng's policies, since Secretary General Zhao Ziyang took firm command in the fall of 1987, will be closely watched at the international level. It will determine how one-fifth of humankind deals with the rest of the world. If there is a return to a radical, unstable political climate, it will be a disruptive force in the world. Fortunately, Deng is retaining the role as Zhao's back-room mentor. On the other hand, there was 70 percent turnover in the 175-member Central Committee at the 13th Communist Party Congress in the Fall of 1987, a call for greater separation of government and party functions, and a pledge by Zhao to pursue defense modernization. The world is watching.

Before closing, I would like to add a personal comment. As I travelled throughout the People's Republic, I saw the people working in the fields, the factories, the universities, and the hotels and relaxing in the parks—resting, practicing "tai ji quan," kite flying, playing cards, and playing musical instruments. The people I met were friendly, polite, kind, and interested in what I had to say. They seemed to be looking forward to less governmental control, greater personal freedom, and more time for relaxation than they have had in past years.

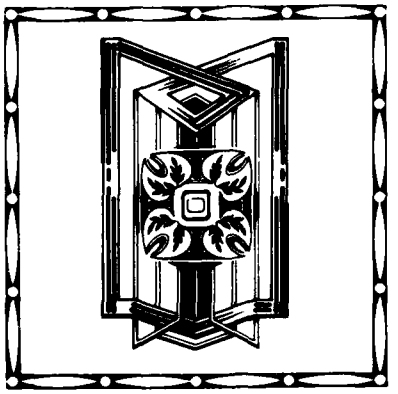
China has been changing direction. Moeen Queresh summed up the situation in China today very well when he said recently, "The *sleeping giant* is not sleeping any more. It is taking giant strides."■

Endnote

1. Moeen Queresh, Senior Vice President of the World Bank, as quoted in *U.S. News and World Report*, September 14, 1987, after he spoke with Chinese leaders in Beijing.

Selected Bibliography

The information contained in this three-part report is the result of visits and discussions with more than 100 engineering, industrial, and business managers, as well as faculty and staff members from organizations identified below. In addition, information from published and unpublished documentation provided by these people during the visits has been used to augment the spoken word.



Beijing

—The Chinese Mechanical Engineering Society (CMES)

—China Association for Science and Technology (CAST)

—Central Institute of Project Planning and Research, Ministry of the Machine Building Industry

—China Ship Research and Development Administration

—Xinghua Engineering Consulting Corporation

—CMES Continuing Engineering Education College

—Beijing Institute of Technology

Shenyang

—Liaoning Mechanical Engineering Association

—Shenyang Mechanical Engineering, Technical Development, and Consulting Corporation

—Zhenxing Mechanical Engineering, Technical Development, and Consulting Corporation

—Liaoning Machine-Building Bureau

—Liaoning Machine-Building Corporation

—Shenyang Blower Works

—Shenyang Transformer Works

—Shenyang No. 1 Machine Tool Works

—Mega Strength Company, Ltd.

—Northeast University of Technology

Hangzhou

—Chinese Association of Enterprise Management

—Zhejiang Association of Enterprise Management

—Zhejiang Federation of Industry and Commerce

—Zhejiang International Trust and Investment Corporation

—Zhejiang Society of Technology, Economy, and Modernization of Management

—Zhejiang Provincial Society of Mechanical Engineering

—Zhejiang Commission, China Democratic National Construction Association

—Zhejiang Provincial Bureau of Machine-Building Industry

—The Democratic State Foundation Party of China

—Southern Engineering Society of China

—National Construction Association

—China State Construction Engineering Corporation

—The Fourth Construction Engineering Corporation

—Hangzhou Heat Energy and Power Company

—Hangzhou Stream Turbine Works

—Duyjinsheng Silk Weaving Factory

—Zhejiang University

Guangzhou

—Guangdong Association of Enterprise Management

—The Chinese Mechanical Engineering Institute at Guangdong

—Guangzhou Mechanical Institute

—The Machinery Building Bureau of Guangdong Province

—The Management Association of the Guangdong Machinery Engineering Union

—The Consultative Services Council of the Guangdong Machinery Engineering Union

—Guangzhou Economic and Technical Development Corporation

—China State Shipbuilding Corporation, Guangzhou Shipyard

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—Guangzhou Decor Porcelain Factory

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—South China Normal University

The author is indebted to Nathan W. Hurt, Jr., vice president of the American Society of Mechanical Engineers and a consultant with Los Alamos Technical Associates, Inc., who served as leader of the Citizen Ambassador delegation; members of the Citizen Ambassador delegation, who provided additional insights; John H. Luppert, Director, Science and Technology Projects, Citizen Ambassador Program, People-to-People International, who made the arrangements for our visit to China; and the three Chinese interpreters, without whom our delegation would have been "adrift in unknown waters" during the visit. ■

AD HOC REPORT

THE DOD CONTRACTING OFFICER

A Study of the Past, An Assessment of the Present, Recommendations for the Future

The ABA Section of Public Contract Law sponsored this study because it was concerned that substantial changes in contracting officers' duties and diffusion of their traditional authority could adversely affect the acquisition process.

The *ad hoc* Committee charged with this responsibility focused its attention on the role of DOD contracting officers. The Committee based its observations and conclusions upon its own collective experience and an informal survey of contracting officers and contractor representatives.

It was the Committee's intention to reframe some of the controversial questions of federal procurement policy within the broad context of the contracting officer's institutional role as it has evolved in the law and in day-to-day practice.

Drawing upon these sources, the *ad hoc* Committee has arrived at certain conclusions and recommendations which are also summarized with supporting rationale in this Executive Summary. They are offered as sound suggestions for increasing the effectiveness of contracting officers and as a step toward improving the productivity of public monies spent for defense.

Nature and Niche of Contracting Officers

The contract between the U.S. Government and its private industrial suppliers defines, limits and governs their relationship. The contracting officer, as the official legally authorized and responsible for entering into and administering the contract, is an essential element in creating this relationship.

The government's requirements met by contracting with the private sector are complex and diverse. This diversity is mirrored by the specific functions performed by contracting officers and contracting organizations.

■ *This is a report by the* Ad Hoc *Committee on the Role of DOD Contracting Officers, Section of Public Contract Law American Bar Association, 1987, Paul G. Dembling, Chairman of the Section, John Cavanagh, Chairman of the Committee.*

Types of Contracting Officers and Organizations

As a practical matter, contracting officers cannot personally accomplish everything necessary to award and administer government contracts. Both Procurement Contracting Officers (those with authority to enter into contracts) and Administrative Contracting Officers (who primarily administer contracts) typically are supported by teams of specialists. They perform such functions as contract negotiation, contract administration, small purchases, price analysis, production surveillance, quality assurance and financial analysis.

With regard to staffing levels in contracting activities, a 1981 study by the Logistics Management Institute concluded that while contracting activities have steadily increased their workload, the workforce has been growing at a much lower rate. The Committee believes that this situation continues to exist today.

Selection of Contracting Officers

The selection process for contracting officers is a matter of great public importance, yet there is no specific statutory guidance for it. The selection system is a mixture of procurement and personnel regulations. The latter are much more significant because they define the civilian contracting specialty which produces the majority of qualified candidates. Typically, contracting officers (except for those who are military officers) are selected after apprenticeship as contract specialists, a position for which there are minimum educational requirements. This results in one of the most frequently criticized characteristics of the contracting officer position—lack of a formal educational requirement. Other criticisms are directed at the relatively low pay grade and low organizational status of contracting officers.

Within DOD, the pool of those eligible for appointment as contracting officers has been broadened by appointing some military officers to those positions.

Efforts to improve the process for selecting contracting officers have left unresolved conflicts between the Office of Personnel Management and the larger procurement agencies, including DOD.

Relationships with Other DOD Officials

Among the many governmental personnel with whom the systems contracting officer must work is the program manager. As the DOD official with overall responsibility for systems acquisition under a major defense acquisition program, the program manager has centralized management authority over all technical and business aspects of the acquisition. However, in DOD the program manager typically does not have the authority to enter into contracts. The division of management authority and contractual authority has generated considerable critical comments.

The contracting officer also has a strong and occasionally controversial relationship with government auditors. Auditors recently have been given broader authority to decide contract cost issues, including a requirement that a contracting officer's disagreement with an auditor must be submitted to higher review.

Complexity of Functions

Contracting officers have a complex role and great diversity in their specific duties. Many of them perform narrow, highly specialized and limited buying functions. This has resulted in diminished importance in the acquisition process because the opportunity to use broad business judgment has been severely diminished. The current acquisition environment blankets the contracting officer with oversight, laws and regulations; the pace of change is too swift to be absorbed and implemented effectively. Fragmentation and scattering of the traditional authority of the contracting officer will in fact obscure accountability for contracting failures.

Authority of DOD Contracting Officers

The power of the federal government to enter into contracts is not enumerated in the Constitution. It is a "resulting power" which flows from the government's essential nature as a discrete political entity. It is shared by all three branches. The Congress has granted this power to the military service secretaries and it also has been delegated by the President to the Executive agency heads. Ultimately, this power devolves through the Warrant System to the contracting officer. The authority it entails is limited, but it does authorize the use of discretion. The ultimate effectiveness of the contracting process rests on sound decisions by the contracting work force. However, the effect of ever-increasing layers of oversight and review is to discourage application of business judgment and innovation by the contracting officer. The certainty of review encourages tentativeness and deference, not decision-making.

Contracting Officers' and Contractors' Perceptions

The Committee tapped into current attitudes and thoughts of contracting officers and contractor personnel through face-to-face interviews and detailed questionnaires. It interviewed 40 contracting officers in the military services and the Defense Logistics Agency. The group reflected the diversity of DOD procurement, representing as it did a wide geographic and functional range.

Key self-perceptions of contracting officers include a belief by some that their ability to do their jobs well has been dampened by "bad press," intense supervision, diminished authority and lower public and peer regard.

Many contracting officers see a trend away from an experienced acquisition work force, and have limited confidence in training opportunities to offset this trend. However, there is a widely held belief that the contracting officer with strong personal qualities will succeed despite the turbulence of the times and excessive oversight.

Many contracting officers are concerned that they are over-regulated and over-supervised. The Committee concludes that this is true and has long-term implications for morale, recruitment, retention of personnel and efficiency. Moreover, the increasing regulatory burden has created a measurable need for a larger work force and more concentrated training.

Contractor representatives—60 of whom responded to the questionnaires—believe that although the contracting officer should be a key element in the acquisition process, that position is increasingly becoming a "conduit" for transmission of judgmental decisions made elsewhere by others. Contractors, like many contracting officers, believe that personal factors which lie outside the authority granted in the contracting officer's warrant—such as personal experience, knowledge and force of personality—determine just how "key" his role will be.

Contractor responses reflect the perceptions of some contracting officers that those holding other functions, most notably auditors and program managers, have increasingly encroached upon the contracting officer's turf. Finally, contractors express a strongly held desire for higher levels of contracting officer manning, training and experience.

Interestingly, there is a strong feeling on the part of both contracting officers and contractors that the relationship between them has not deteriorated. This relationship is viewed as "adversarial" in the best sense; i.e., one which serves the public interest. While the managerial style of some contracting officers may have changed, there is a general view of the contracting officer—contractor relationship as being a sound, arms'-length relationship with the contracting officer vigorously protecting public interests.

Conclusions

1. *There Is a Steady and Continuous Erosion of the Authority of DOD Contracting Officers.*

One of the greatest powers exercised by the United States through the Defense Department is the power to contract. The security of the nation depends in large part on how effectively and efficiently this power is implemented in procuring essential weapons, supplies and services. The Government also uses the contracting process as a vehicle for implementing major social and economic policies. As the official responsible for assuring that the contract effectively provides for these dual functions, the contracting officer should have the authority to fulfill the mission of contracting in the most efficient and economical way, while assuring that the spirit and the intent of the law is faithfully implemented. This is not the condition which exists today. The role of the DOD contracting officer is changing from the traditional position of strength to a less well-defined position of diminished significance and shared authority. Rather than stimulating efficiency, initiative and imagination, the current acquisition environment blankets the contracting officer with oversight, laws and regulations. The magnitude of new laws and regulations has thrown a shadow on the contracting officer's authority, and the pace of change is too swift to be absorbed and implemented effectively. In addition, the authority of contracting officers has been fractured with pieces of this authority assigned to or assumed by various program and staff officials. Such diffusion of authority can only mean a diminished role for the contracting officer which, extended to the ultimate conclusion, will result in no identifiable Government official at the operating level being responsible for efficient contracting practices or accountable for contracting failures.

2. *Increased Regulation and Legislation Leads to Inefficiency.*

The Committee recognizes that one reaction to the reported failures and abuses in the acquisition process has been more congressional oversight,

Real professional growth is stymied by the imperative of learning what are new wickets through which contract action must pass.

legislation and regulation. Many factors are responsible for this fact, not the least significant of which is the duty of the Congress to assure that defense dollars are properly spent. A 1985 report by the staff of the Senate Commitee on Armed Services showed that the number of congressional requests for studies and reports increased 1117 percent from 1970 to 1985, that other mandated actions for DOD increased by 1022 percent, and that the general provisions in the annual authorization and appropriation acts increased by 233 percent in that period.

One ultimate effect of more oversight and more laws is to make contracting officers less efficient in their work and more focused on contracting as an administrative process than on the ultimate purpose of filling the procurement needs of the agency. In this atmosphere of intense oversight and close regulation, correct procedure becomes more important than substantive success in acquisition. Contracting officers can be so confined by compliance with regulations and satisfying oversight and review that they are afraid to express ideas and afraid to act beyond their familiar routines. Contracting actions become mechanical; imagination, judgment and common sense dry up. In the opinion of the Committee this is one of the most inefficient and costly aspects of the DOD acquisition process.

Additionally, constant changes in laws and regulations serve to neutralize the value of past training in contracting procedure. Largely as a result of new laws, most of the more than 1,000 pages of the Federal Acquisition Regulation have been changed during the past 2½ years. Continuous new training is necessary just to keep up. Real professional growth is stymied by the imperative of learning what are the new wickets through which the contract action must pass.

3. *The High Quality of the Procurement Work Force Must Be Maintained Because It Is Important to National Defense.*

The Committee members, with their varying and extensive experience in the Government contracts field, have had the occasion over time to view DOD contracting officers from different perspectives. Yet the Committee readily reached a consensus, based on their experience, on the extreme importance of the contracting officer function and the necessity of assuring that contracting officers are enabled and encouraged to perform that function well. The Committee's interviews with contracting officers fortified these opinions. In addition, the information received from contractors was impressive in showing strong awareness that highly qualified contracting officers are essential to the effective formation and efficient performance of Government contracts. In short, the experience of performing this study increased both the awareness of Committee members as to the functional problems faced by DOD contracting officers and the recognition that those problems must be and can be solved. This experience also has confirmed and strengthened the Committee's high regard for DOD contracting officers. The contracting work force is a valuable asset for national defense.

Recommendations

1. *A significant number of DOD contracting officers should be granted professional status in the Civil Service and such status should be reflected in their selection, education, and career management.*

Given the increasing complexity of the acquisition process, the Committee strongly endorses the proposals that have been made by the Commission on Government Procurement, the U.S. General Accounting Office, and the Packard Commission that some contracting personnel be recognized as having professional status. The Committee recognizes the difficulty of determining which categories and which individuals within categories of those involved in contracting activities should be accorded professional status. Specific suggestions are:

—Weight should be given to on-the-job experience.
—The contracting function should not be segregated into a separate acquisition agency.
—Prospective contracting officers should be selected from among individuals with a college degree in business, engineering or study in a closely relevant field.
—Specialized training in defense acquisition, continuing education, and assignments providing a broad base of experience should be provided to contracting officers.
—Special management emphasis should be devoted to raising the prestige and morale of contracting officers by according them job status and pay benefits commensurate with responsibility.
—A high-level official, reporting directly to the agency senior acquisition official, should be designated as the proponent for contracting officers' professional recognition.

2. *The Contracting Officer Program Manager Role.*

—The present line of authority from the contracting officer, through the HCA, to the Service Senior Acquisition Official should be preserved.
—Program managers should be provided with more contracting officer support earlier in the acquisition cycle.
—The contracting officer should be the program manager's business planning advisor and representative to industry.
—Contracting officers and program managers should train together.

The Committee does not believe that the tension which characterizes the relationship between the contracting officer and the program manager can or should be eliminated. The present line of authority from the contracting officer to the Service Senior Acquisition Official provides support to the contracting officer and allows a reciprocal check and balance between program officials and contracting officers.

The Committee believes that difficulties between program management officials and contracting officers can be reduced by providing program managers with more contracting officer support and providing this support earlier when it would make more of a difference in acquisition planning.

Although we have not attempted specifically to define what the functional relationships between the contracting officer and the program managers should be, the Committee believes that the contracting officer should fulfill two key functions in support of the program manager.

One would be as a trusted advisor on contracting related issues and business decisions, including the planning of competition and assisting in development of the source selection plan, the request for proposals, and the type of contract. The second function would be as the single contracting face to industry. In this capacity the contracting officer would conduct preaward discussions with the contractor, participate in evaluation of proposals, set the competitive range and conduct the award notification and debriefings. While not necessarily in charge of the program, the contracting officer would be in charge of the contracting process.

Common experiences and interchange outside the formal program manager/contracting officer structure should foster a closer working relationship; this can be accomplished in part by training at a common facility such as the *Defense Systems Management College*. There are common courses which both should attend. Collegiate contact should promote mutual understanding and respect as well as an improved learning experience.

3. *The decision-making role of the contracting officer in audit matters should be preserved, with the auditor as a key advisor to the contracting officer.*

No relationship in the contracting process is more fraught with current controversy than that of the contracting officer/contract auditor. The precise role that the auditor holds in the contracting process has been strengthened by legislative action.

The Committee acknowledges that the audit function is an important one in both the formation and the subsequent administration of defense contracts. However, given the traditional, sound and generally applicable doctrine that the contracting officer is the sole government official with authority to take contractually binding actions, the auditor's role should be advisory to and functionally supportive of the contracting officer. By this it is not intended that the DCAA auditor be organizationally subordinate to the contracting officer. The auditor's advice and opinions on cost and pricing issues within the professional competence of the auditor are to be given great weight by contracting officers. As in other intra-government relationships, the principle of check and balance is important. Nevertheless, as the contracting officer is ultimately responsible legally for the contract, the contracting officer and not the auditor should have the final voice in the event of disagreement. The Committee believes that the contracting officer/auditor relationship should be put back into balance.

4. *The Congress should declare a moratorium on DOD procurement reform until DOD has had a reasonable time to digest and implement recent reform legislation.*

Contracting officers and contractors alike believe that new procurement laws and new regulations constitute an ever-increasing burden on the entire acquisition process. In the 1980s, hardly a year goes by without a new procurement reform or procurement improvement being passed by the Congress.

The Committee believes that the Congress should distinguish between situations where DOD needs additional legislative authority to act in the acquisition process from situations where new law tells the acquisition work force how to do its job. It is the latter type of legislation which is seen as harmful to the status and role of contracting officers as well as inimical to effective and efficient contracting. Much of the recent legislation which has been directed at telling the contracting work force how to do its job has been a response to a very specific problem. Unfortunately, statutory remedies tend to sweep much more broadly than the problems they are intended to correct. This can produce untold effects and manifold complexities.

5. *New acquisition regulations should avoid excessive detail and encourage the exercise of discretion for unique situations.*

Contracting officers and contractors also believe that new regulations constitute an ever-increasing burden on the entire acquisition process. These regulations often leave little to the discretion of the contracting officer or the acquisition team which may be assisting with the procurement.

As an example, the Committee notes that the requirements for repetitive high-level reviews of acquisition actions can create real turbulence in the acquisition process. The Committee urges that defense executives carefully examine the entire network of contract reviews with the goal of eliminating those which are not necessary in the exercise of good decentralized management. Contracting officers should have significant participation in the internal decision-making process; this participation will be enhanced if contracting officers are not constantly justifying their judgment.

The Committee believes that both contractors and DOD acquisition officials should recognize that regulations are by their nature more flexible in application than are permanent statutes. Regulations should be drawn and applied with this in mind. When a unique contracting situation does not fit a specific regulatory scheme, acquisition officials should not "force a fit." Rather, the Committee recommends that the regulations provide for the exercise of discretion at appropriate levels and that both contractors and acquisition officials be encouraged to consider the use of this discretion in genuinely unique situations.

6. *The number of contracting officers and their support staff should match the volume of contract actions.*

The Committee found that all contracting officers identified an increased workload as a significant problem in

Many DOD contracting officers work in physical facilities that are small, crowded, and not conducive to efficient work.

their job. This is not surprising considering the work imposed by the constantly growing body of acquisition laws and regulations.

A similar conclusion was reached by the Logistics Management Institute in its study, *Procurement Workload Versus Workforce—A Growing Imbalance*. In its study, the Institute concluded, based upon a rigorous statistical study of Department of Defense contracting, that the volume of procurement actions was increasing at a significant rate. It compared this to the rate of increase in contracting personnel which was substantially lower. This resulted in a trend toward ever greater overwork.

The measurable impact of this trend toward overwork was a significantly higher separation rate for contracting personnel than for other civilian employees of DOD. There was also a dangerous trend toward more junior employees as measured by length of service. These trends were more pronounced at those activities where the imbalance was greater than the norm.

The Committee believes that this imbalance must be corrected. The number of contracting officers should match the volume of contract actions. These contracting officers require the support staff to assist them in the performance of their duties, including buyers, administrators, clerical personnel, and the necessary support personnel such as auditors, price analysts, quality assurance and industrial specialists. In this regard, individual contracting officers should supervise a smaller number of buyers. This latter recommendation reflects the concerns of several contracting officers. The Committee also observed that many DOD contracting officers work in physical facilities that are small, crowded, and otherwise not conducive to efficient work.

The Committee predicts that as individual workloads are reduced, professional contracting officers will continue to increase the quality of their work. Along with increased retention, this should significantly promote an effective contracting work force.

Concluding Comment

The Committee is convinced that adoption of its recommendations will contribute positively to confirming and strengthening the authority and status of DOD contracting officers, resulting in improved efficiency and effectiveness in the total acquisition process. ■

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GREET THAT NEW LIEUTENANT!

But That's Not All!

Major (Select) Donald J. Vazquez, USAF
Colonel Dale O. Condit, USAF

Can you recall how you were greeted at your first job or duty assignment? Chances are you may have been greeted with a tentative "Uh...you're here? Read these regulations and operating procedures, and let me know if you have any questions." Wouldn't you have preferred, or expected, a more organized welcome?

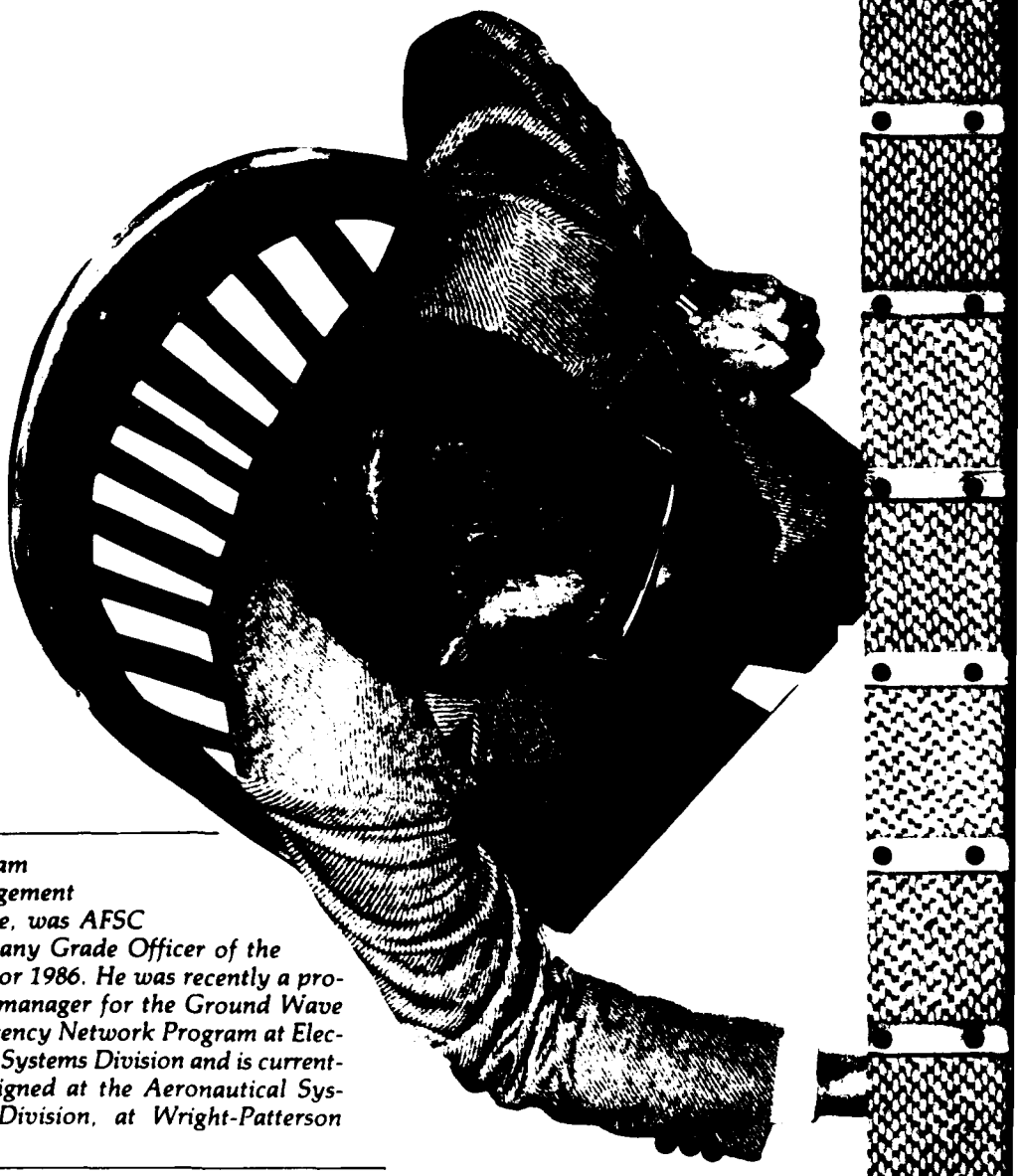
There's a probability an initial greeting you received was followed by a systematic framework to help maximize your contribution to the organizational mission, and your personal development. An article in the May-June 1984 issue of *Program Manager* provided a starting point from which to greet new lieutenants effectively in "Greet That New Lieutenant."[1] That's not the end of it, however. An articultate welcome outlining organizational mission, goals, and expectations should be the start. Herein we provide a framework to organize a supervisor's leadership responsibility—followup.

This framework consists of essential sequiturs—things that must follow—to the initial welcome: performance evaluation and feedback, training, career counseling, and challenging jobs. We outline the critically important step of ongoing evaluation and feedback and how to use a "ruthless" effectiveness report.

The training section aims at helping impart knowledge necessary for young officers to contribute, compete, and survive via available courses and formal programs; for example, graduate work and the Air Force's recently instituted Acquisition Career Track.

The third section concerns career counseling to lead lieutenants toward appropriate assignments, for Air Force and individual benefit.

Finally, we touch on the essential of providing challenging jobs—environments in which lieutenants can imple-



■ *A 1987 graduate of the Air War College and recipient of the Secretary of the Air Force Leadership Award, Colonel Condit is an experienced program manager in Air Force Systems Command, managing the Hypersonic Glide Vehicle Program at the Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB. Major (Select) Vazquez, recent graduate of the Defense Systems Management College Program Management Course, was AFSC Company Grade Officer of the Year for 1986. He was recently a program manager for the Ground Wave Emergency Network Program at Electronic Systems Division and is currently assigned at the Aeronautical Systems Division, at Wright-Patterson AFB.*

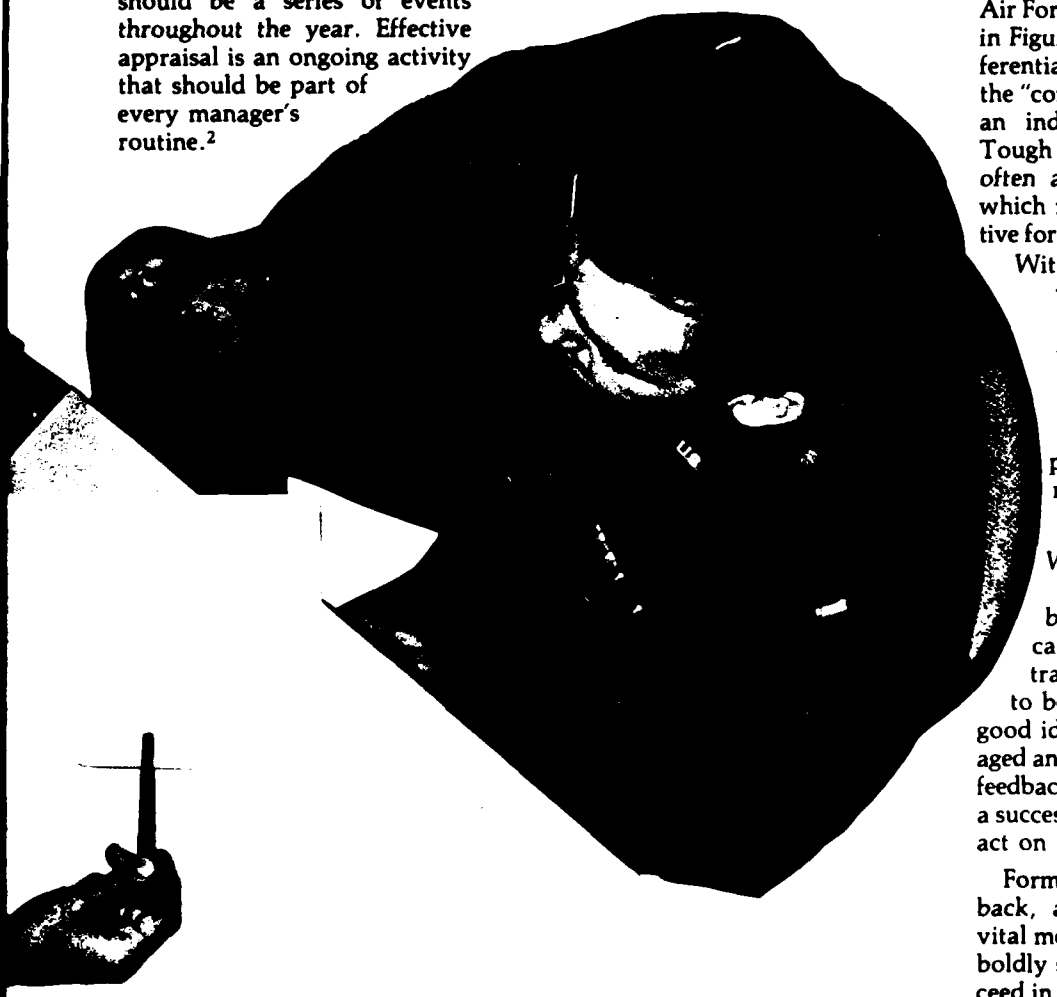
ment newly developed skills. We intend to provide a framework to formulate an effective follow-up plan for novice officers to ensure they can be competent, motivated, and productive.

Now that you've greeted that new lieutenant, begin the follow-up by implementing an evaluation and feedback plan.

Essential Sequitur 1: Evaluation and Feedback

A formal and informal performance evaluation and feedback plan can start easily when the new lieutenant sets foot in the program office. This is the most critical leadership a supervisor can provide a novice officer. In the August 1987 *Training Magazine* article entitled "Performance Management: Not Just an Annual Appraisal," Kathleen Guinn establishes the critical evaluation and feedback philosophy:

> Performance appraisal is not an annual event. For best results, it should be a series of events throughout the year. Effective appraisal is an ongoing activity that should be part of every manager's routine.[2]



You have probably heard that before. What does it mean, and how do you implement it? Easy. A two-step process of using constant informal feedback should be matched to formal sessions, aimed at nurturing, teaching, and creating what Bennis and Nanus refer to as "positive self-regard."[3] The positive self-regard you seek to create is a sense of self-confidence and high expectations in lieutenants, an environment which will help them realize their potential.

Do not forget your aim in this effort. It is to create and cultivate what Fournies calls, in effect, "successful subordinates."[4] Guinn offers reasons why traditional approaches to performance evaluation and feedback fail. Appraisals are perceived as confrontational. Many supervisors and subordinates cannot separate personal worth from performance appraisal. Few managers articulate the reason for the evaluation; reviewing past performance to provide a base for planning future performance. Don't focus on filling out the effectiveness report during these sessions—you are dealing with a person, *not* a piece of paper. Establish clear-cut action plans. Many sessions end without a defined vector, direction and velocity, upon which to act.

You can implement a continual program of evaluation and feedback by constantly providing informal feedback; i.e., "I really thought that was a fine briefing you prepared," to giving an action which allows people to work closely with you. Tell lieutenants you want self-evaluations of their own progress and plans. Encourage them to ask *occasionally* how they are doing and how they can improve. Emphasizing introspection helps ensure the self-improvement burden is shared between individual and supervisor.

One of our favorite tools for the formal feedback session is the "ruthless" effectiveness report, illustrated by the Air Force Officer Effectiveness Report in Figure 1. The word "absolute" differentiates this "ruthless" report from the "comparative" one given as part of an individual's official evaluation. Tough evaluations in certain areas often are not in submitted reports, which may be "inflated" and ineffective for encouraging self-improvement.

> With the "ruthless" report, which we use in a formal evaluation at report time, we can make comments often not found on the submitted report—from candid evaluations of weaknesses you believe need improvement to genuine remarks regarding strengths.

We hasten to add the supervisor will seek effective feedback from the lieutenant, who can experience supervising frustrations, which should be heard to be alleviated. Lieutenants have good ideas, which should be encouraged and implemented. We believe this feedback is a good way to help fashion a successful lieutenant, but only if you act on feedback.

Formal feedback, informal feedback, and evaluation sessions send vital messages to lieutenants. You are boldly stating you want them to succeed in a manner that is "low threat," aimed at training better officers and

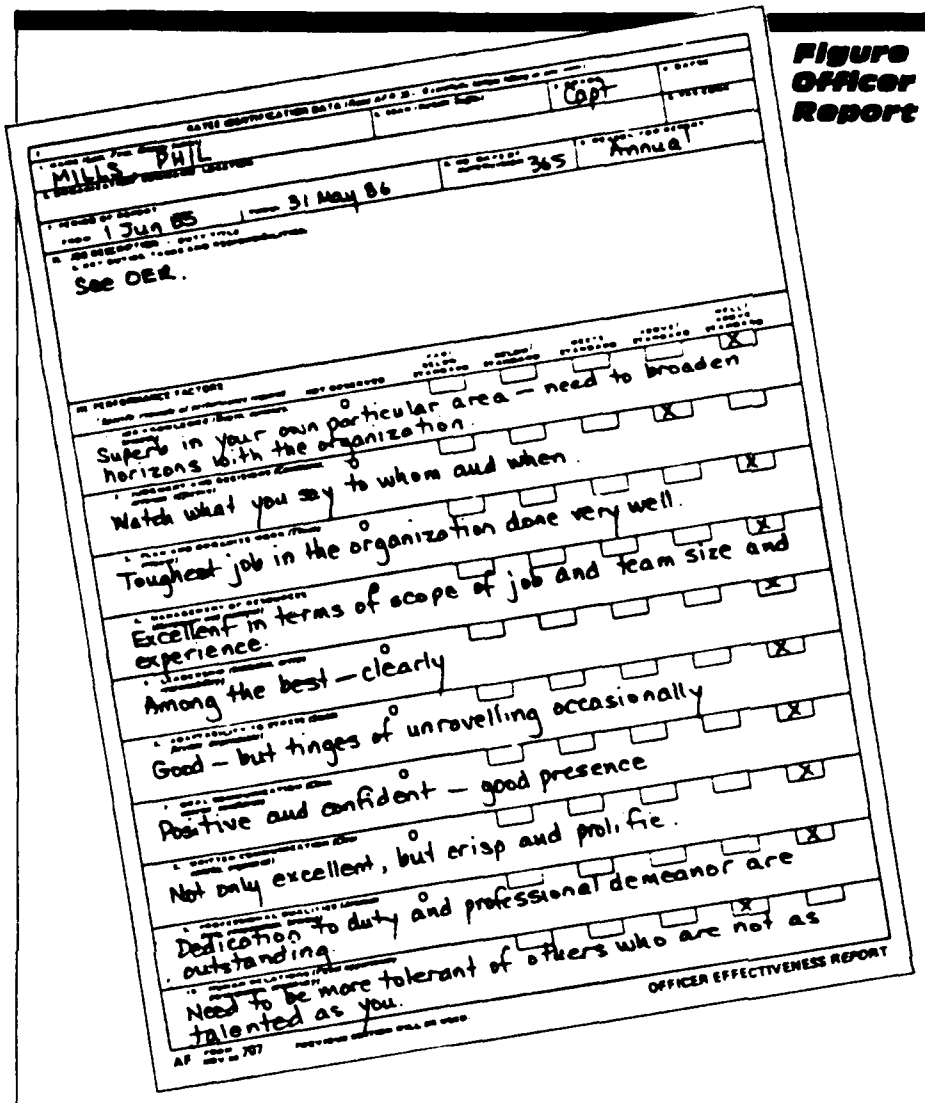

MILLS PHIL
Capt
1 Jun 85
31 May 86
365
Annual
See OER.
Superb in your own particular area — need to broaden horizons with the organization.
Watch what you say to whom and when.
Toughest job in the organization done very well.
Excellent in terms of scope of job and team size and experience.
Among the best — clearly
Good — but tinges of unravelling occasionally
Positive and confident — good presence
Not only excellent, but crisp and prolific.
Dedication to duty and professional demeanor are outstanding.
Need to be more tolerant of others who are not as talented as you.
OFFICER EFFECTIVENESS REPORT

Figure 1. The "Ruthless" Officer Effectiveness Report

leaving out personalities. You demonstrate you have approached this issue in a well-thought-out manner by using your own experiences. Guinn summarizes steps you have initiated:

1. Performance Planning: The process of identifying the desired performance and commitment.
2. Performance Managing: The daily process of working toward performance expectations.
3. Performance Appraisal: The assessment of performance trends and plans for the future.[5]

Essential Sequitur 2: Training

Training is crucial to everyone's professional growth, especially the new lieutenant. It can be in the forms of on-the-job, informal or formal coursework, or "specialized" training. We all wish we could have been trained before an assignment. How often do supervisors say: "I can't afford to lose Lieutenant Jones for two weeks." Responsible for accomplishing the mission, supervisors must decide when subordinates can be spared and should know what courses are available and applicable; select a 1-week course instead of a 3-week one if you perceive it comprises the same learning. In the systems acquisition area, many courses train new lieutenants, as shown in Table 1. You don't have to send lieutenants to all available courses; however, by selecting formal courses, you send the important message that they are an asset, and you want them to be the best. This approach motivates and educates lieutenants to accomplish their work.

Programs like the Air Force Systems Command Acquisition Management Career Development Model are necessary for increased responsibilities, and foster the training process. In the Acquisition Career Model, four levels of qualifications require increasing training and experience. The individual progressively moves toward a major system program director's assignment. Some courses, like the Air Force Institute of Technology Systems 100, or its follow-on Systems 200, are required for acquisiton officers and ought to be planned as early as possible in a new lieutenant's tenure. They would get an early overview of the acquisition business and benefit before getting deeply involved in functional areas of the program. Select a few, worthwhile courses for every new lieutenant; and so inform them on arrival.

We also emphasize Professional Military Education and graduate study. Stress the need to balance these. This is tough to do and must be carefully planned with supervisory help. Completing Squadron Officer School (or other services' equivalents) by correspondence before making the rank of captain should be every lieutenant's goal. This program takes 6-12 months to complete; we have encouraged lieutenants to form study seminars to aid each other's progress through the program, and to provide a forum for the exchange of ideas. The 8-week, in-residence program is worthwhile and should be considered as your top lieutenants' "post-graduate" professional course. Graduate work must be encouraged because education is a continuing process. Personal philosophy is to get professional military education done as a lieutenant, and graduate work after making captain. Choose between full-time or part-time study. There is another "balancing" consideration. Full-time study is the most efficient approach to develop skills as a "body of knowledge," yet it removes one from important "experience avenues" for 1-2 years. A part-time approach can be the best of two worlds—getting good job experience and continuing one's education. One often balances other priorities too.

Expect your program office training monitor to track organizational details; you are the initiator, not the implementor. The supervisor's responsibility is to ensure intellectual and professional growth to get the mission ac-

complished. Now, career counseling provides a future perspective for the new lieutenant.

Essential Sequitur 3: Career Counseling

What do you do with the lieutenant excelling in your well-developed performance and evaluation and training program? What about the lieutenant who doesn't? The answer is career counseling. Talk with the lieutenants about assignments and realities of promotions. Remember that what you know comes from years of experience, something the lieutenants lack. Your job is to get the mission accomplished, and that is easier with informed and motivated subordinates, including lieutenants thinking about service careers.

Most lieutenants, new to the military, often don't know what constitutes a good assignment or how to find one. Insist they begin work on a career plan via the institutional assignment preference form (i.e., Air Force Form 90) and a personal career path, using a form similar to Figure 2. Encourage them to think and act. Meyer says "writing crystallizes thought, and thought motivates action."[6] Putting a career plan on paper is the first step toward reality. Counsel lieutenants on what constitutes a good assignment or a bad one and insist they ask questions about assignments.

Good assignments, matched to the lieutenant's abilities, and outstanding performance provide the opportunity for promotion, the path to increased responsibilities and contribution to the mission. Make sure they know the realities of promotions and have goals in consonance with their expectations and abilities.

Essential Sequitur 4: Challenge

Today's good lieutenants need to tackle challenging jobs earlier because of the quality of their preparation before entering the services. Challenge them! This provides that last and most important motivation increment to achieve the mission, and for personal goals. Challenge determines who wants more responsibility. We believe the best way to do this is with an incremental approach with lieutenants; give them 1-2 small projects to start to give them confidence. Then, according to abilities displayed, continually add to the number, complexity, and significance of the tasks. Thus, you help each to grow at an individual pace, while you spot those with the greatest potential.

Career counseling and challenge cement this framework to help in your significant leadership responsiblities to develop the best possible lieutenant.

Table 1. Sample of Available Courses At the Defense Systems Management College, Fort Belvoir, VA.

- —Basics of Defense Acquisition
- —Fundamentals of Systems Acquisition Management Course
- —Systems Acquisition Funds Management Course
- —Systems Engineering Management Course
- —Contract Management for Program Managers
- —Contractor Performance Measurement Course
- —Contract Finance for Program Managers
- —Defense Manufacturing Management Course
- —Management of Acquisition Logistics
- —Management of Software Acquisition
- —Test and Evaluation Management Course
- —Technical Managers Advanced Workshop
- —Program Managers Briefing Course

You help each to grow at an individual pace, while you spot those with the greatest potential.

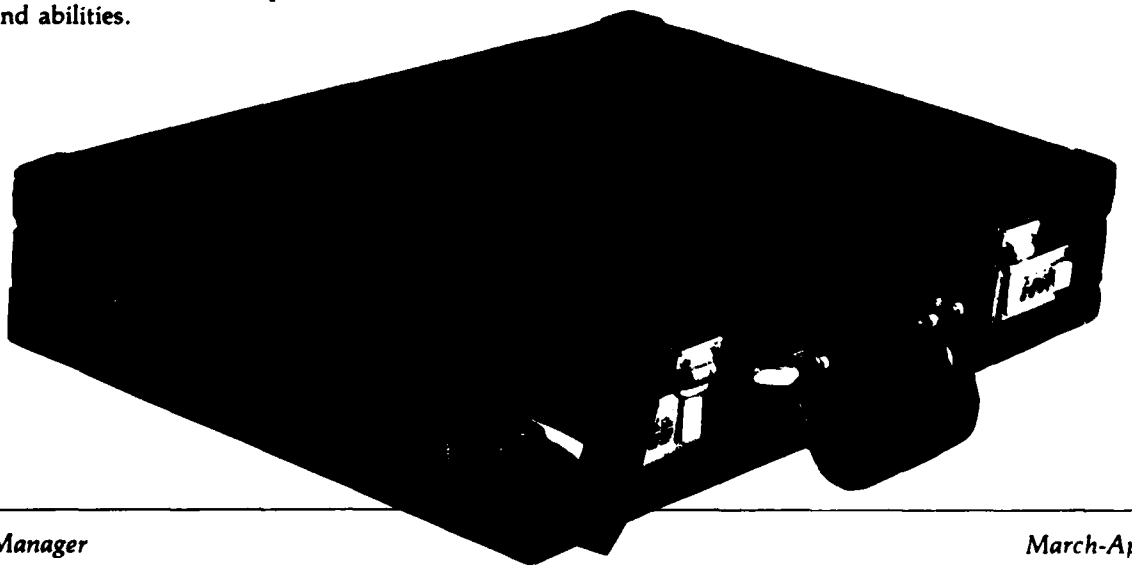
Conclusion

The framework we have discussed is summarized in the following outline:

—*Greet That New Lieutenant:* Provide an overview of organization, its goals and climate, and what you expect of them and they can expect from you.

—*Performance Evaluation and Feedback*

1. Continual process of regular, informal feedback.



2. Occasional formal feedback sessions.
   a. Foster self-evaluation.
   b. Feedback on how you can better supervise.

—Training

1. Make courses known.
2. Balance PME, job-related training, graduate coursework.
3. Use organizational training monitor to implement.

—Career Counseling

1. Mapping next assignment and career path.
2. Provide information on special assignments.
3. Provide understanding of promotion opportunities.

—Provide Challenge

While we have concentrated on new lieutenants, what we have discussed is equally applicable to young, civilian employees entering government service. They are as critical to accomplishing the mission and serving the nation through Civil Service careers, and require careful attention.

When do you get time to implement all this? We empathize with you. However, like other results of high-quality leadership, "But That's Not the End of It" takes careful planning and energetic action. It is hard work. Imagine, though, an office full of people leading in respective areas of responsibility. How much more effective your unit could be.

The follow-up to your initial greeting is necessary to produce competent, motivated young officers; but remember, that's not the end of it!■

Figure 2. Career Planning Worksheet

	87	88	89	90	91	92	93
	▼	▼	▼	▼	▼	▼	▼
I. ASSIGNMENTS							
A. Present Assignment							
B. Next Assignment							
C. Next Assignment Plus One							
II. LONG-RANGE GOALS							
A. Long-Range Position Goal(s):							
B. Long-Range Grade Goal(s):							
III. SCHOOLS/COURSES I WISH TO ATTEND							
A.							
B.							
C.							
IV. SPECIAL ASSIGNMENTS I AM CONSIDERING							
V. OTHER PERTINENT DATA							

GRADE/NAME: _____

DATE: _____

Endnotes

1. Dale O. Condit and Bradley D. Duty, "Greet That New Lieutenant," *Program Manager*, (May-June 1984), pp. 36-37/47.
2. Kathleen Guinn, "Performance Management: Not Just an Annual Appraisal," *Training*, (August 1987), pp. 39-42.
3. Warren Bennis and Burt Nanus, *Leaders: Strategies for Taking Charge*, New York: Harper and Row, (1985).
4. Ferdinand F. Fournies, *Coaching for Improved Work Performance*, New York: Van Nostrand and Reiholds Company, 1978.
5. Guinn.
6. Paul J. Meyer, *The Dynamics of Personal Leadership*, Waco, Texas: Leadership Management, Inc., (1982), Chapter 7, p.5.

Fifth DSMC Alumni Symposium

The 1988 symposium, scheduled for May 17-19, will be held at the College. The program will be built around improving the relationship between government and industry on defense systems programs. Mike Stacy, PMC 84-1, is chairman. Al Hey, PMC 83-1, Association president, predicts this symposium will be the best one to date. The next issue of the Alumni Association Newsletter will contain program details.

To join the Association, contact Professor David D. Acker at DSMC by letter or telephone (Com) (703)664-4795 or (Autovon) 354-4795.

The Association Board of Directors meets with President Hey (center) at DSMC to plan for May symposium

COMPETITION

EFFECTS OF JUST-IN-TIME MANUFACTURING SYSTEMS ON MILITARY PURCHASING

Major Lance J. Besser
Dayal Kiringoda
Il-woon Kim

Many U.S. manufacturing firms have changed or are modifying their manufacturing systems to meet increased competition in the international marketplace. This includes firms in the defense industry. The changes include CIM (computer integrated manufacturing), FMS (flexible manufacturing systems), and JIT (just-in-time manufacturing systems). The JIT was originally introduced by Toyota in the 1950s as an inventory control technique. It has a significant impact on all functional areas of manufacturing. Specifically, many firms implementing JIT have successfully improved product quality, increased reliability of promised delivery times, and reduced product costs. The program manager is vitally interested in these three areas: product quality, delivery time, and cost.

By understanding JIT, the program manager should be better prepared to understand the production process, cost structure, delivery schedule and problems of firms using that system, and pursue contracts more effectively. The following explains basic JIT concepts and cites examples demonstrating how this new system works, comparing it to former practices. Let's first consider development of JIT in U.S. defense industries.

JIT in the U.S. Defense Industry

The JIT only recently came to the United States. Robert Schonberger, recognized authority on JIT, wrote in 1982:[1]

> In one sense it is a bit early to write about just-in-time manufacturing management in the United States. JIT has scarcely been tested here, and what few examples there are have too brief a history to offer conclusive guidance on how to adapt Japanese JIT to the American environment.

In 1986 he stated, that to survive in a highly competitive market and become world-class manufacturers, U.S. firms should adopt JIT and overhaul their manufacturing apparatus.[2] After his observations of many U.S. firms that have introduced JIT, he concluded that continual improvement in quality, cost, lead time, and customer service (objectives which seem to be in conflict with each other) can be pursued simultaneously in a JIT environment. The appendix of his book lists 84 manufacturing firms in the United States that have successfully implemented JIT and have related achievements. Defense industry examples from that list include:

—Omark, Onalaska, Wis. Gun cleaning kits. Lead time cut from 2 weeks to 1 day, inventory cut 94 percent.

—Omark, Oroville, Calif. Reloading equipment for firearms. Lead time cut from 6 weeks to 2 days, 96 percent of machines relocated into flow lines.

—General Electric, Cincinnati, Ohio. Servicing of aviation turbine blades. Lead time cut from 13 weeks to 9 hours.

—Texas Instruments, Sherman, Texas. Defense weapons systems. In metal fabrication: cut work-in-process from 18,000 to less than 1,000 pieces. Cut production lead time from 14 days to 2 days. Cut scrap and rework four to five fold. In magnetics: cut work-in-process 30 to 60 percent. Cut production lead time 50 to 70 percent. Cut scrap 50 to 100 percent. Overall: cut floor space 40 percent.

Due to successes like these, many firms are expected to adopt or attempt to adopt JIT concepts in the near future. A recent survey indicated that 72 percent of the 1,000 firms surveyed either have a JIT program in place or are planning to adopt one.[3] As shown in Figure 1, this percentage represents a gain of 12 percent more than a similar survey conducted 2 years ago. The recent survey noted American firms are in a hurry to adopt JIT to meet foreign competition.

The JIT must be recognized as a total manufacturing approach and not a mere inventory control technique. Because it affects the entire operating system of a firm, the separate JIT discussions following concern an inventory management technique, a production technique, and a purchasing management technique. Within each, JIT systems are contrasted with traditional approaches. Effects on product quality, manufacturing costs, and delivery time are considered.

JIT Inventory System

The objective of inventory management is to minimize inventory related costs, including three categories: holding or storage costs and even financing costs that result from keeping inventories; reorder costs including for manufacturing, setup costs, and for purchasing, order costs; and stockout costs. The hoped for optimal inventory level is traditionally calculated by using the EOQ (economic order quantity) model, which is based on several assumptions, two of which are: holding costs increase with increasing inventory levels; reorder or setup costs and stockout costs decrease with in-

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creasing size of inventories. Figure 2 shows the trade-off between inventory level and these costs. The economic order quantity and resulting optimal inventory level is represented by and read off the graph at the point where total costs are minimized. P* is this point in Figure 2.

Developed by Ford Harris in 1915, the EOQ model has been regarded ever since as the standard in inventory control systems. Many variations and elaborations have been developed; for example, some include probabilistic considerations. Even where it is not formally utilized in practice, its basic concepts and assumptions are often incorporated into the inventory policy of firms in an attempt to minimize total inventory related costs.

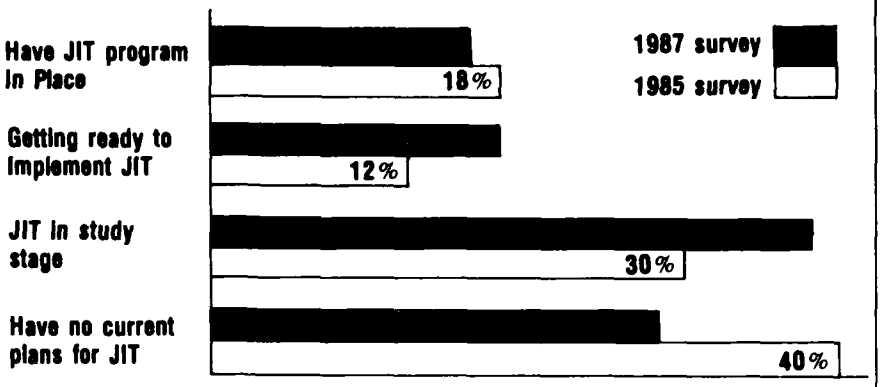
In a JIT environment it can be shown that one of the EOQ assumptions is not valid. That is, reorder/setup and stockout costs do not always increase with smaller inventory levels. When the JIT production and JIT purchasing practices discussed in the following sections are successfully operating, stockout costs of inventories become insignificant and reorder and setup costs are almost fixed at a low level. The JIT model is shown in Figure 3. Clearly with this assumption, total costs are lowest at a zero inventory level where holding costs are entirely eliminated.

Hence, all inventory is regarded as a bad practice by JIT firms that take the achievement of zero inventory levels as the objective of inventory management. It is difficult to visualize a firm operating without inventories because this system is a large departure from traditional practices. Schonberger explains how easily a firm can reduce inventory levels in practice:[4]

> ...produce and deliver finished goods just in time to be sold, subassemblies just in time to be assembled into finished goods, fabricated parts just in time to go into subassemblies, and purchased materials just in time to be transformed into fabricated parts.

A result of these JIT inventory system practices is a significant reduction in manufacturing costs. Inventory holding costs are minimized, and reorder and setup costs are reduced. Losses from spoilage, theft, fire, and

Figure 1. JIT: On A Roll in the U.S.



Source: Purchasing Survey

Figure 2. EOQ Inventory Model

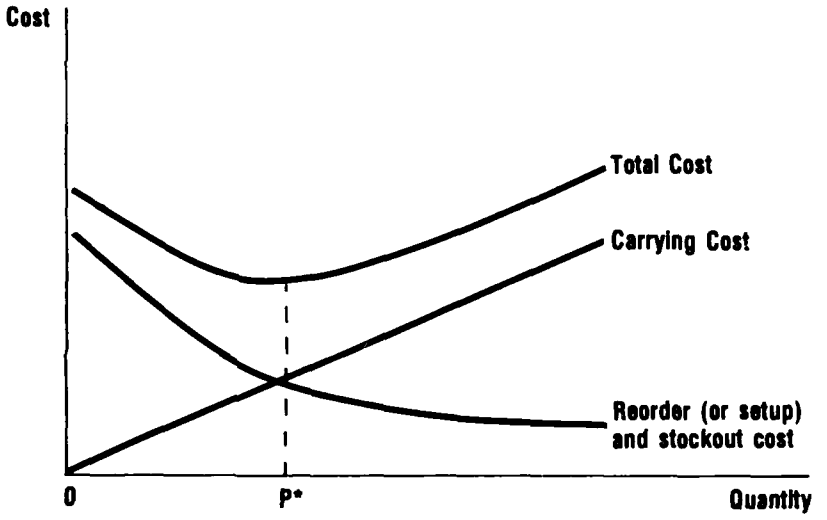
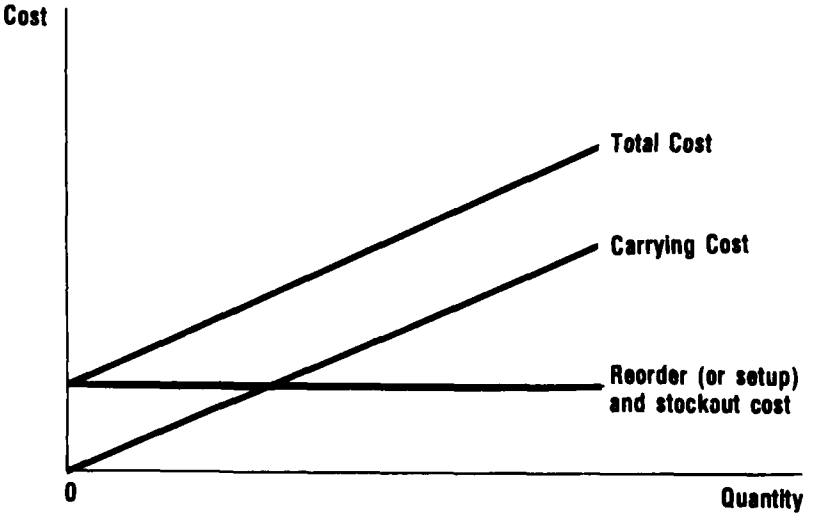


Figure 3. JIT Inventory Model



other hazards are minimized. All these result in lower insurance costs, a more simplified accounting system, and savings in the record keeping effort for inventories.

JIT Production

To achieve the ultimate objective of zero inventory levels, JIT firms must produce work-in-process and finished goods on time. Since these inventories are produced only when needed, the plant should be organized appropriately. This means production with zero defects within a very short period of time.

JIT Plant Configurations

In the conventional U.S. manufacturing process, an assembly line produces homogeneous products in large quantities. Machines are arranged by processes. Each worker specializes in a single function. That traditional plant layout is shown in Figure 4 where it is assumed that one worker performs the same operation on two machines. With specialized workers in this mass production system, efficiency can be increased significantly. When demand is high and customer preference limited, this approach is an effective way to increase market share and profit; i.e., it worked for Henry Ford, when all Ford cars were painted black.

In modern times, however, markets are more competitive and unstable due to rapid technological changes and extensive diversification of customer preferences. Consequently, product life cycles are shorter and demand forecasting is more difficult. In these circumstances, the mass production system that creates a large inventory would not be appropriate; instead, flexibility is needed.

To decrease inventory and thereby be able to respond to changes in markets more rapidly, JIT firms have adopted a flexible manufacturing system as shown in Figure 5. Again it is assumed that a worker operates two machines, with each machine used for a different function. Each work center is equipped with two different machines and all machines are located close to one another. Only one part is made at a time and it is handed to the next person. There is no need for a work-in-process inventory at each work center. Johnson and Kaplan emphasize this point:[5]

Figure 4. Traditional Plant Layout

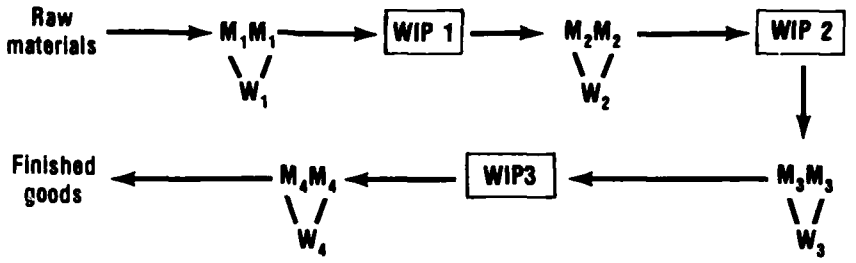
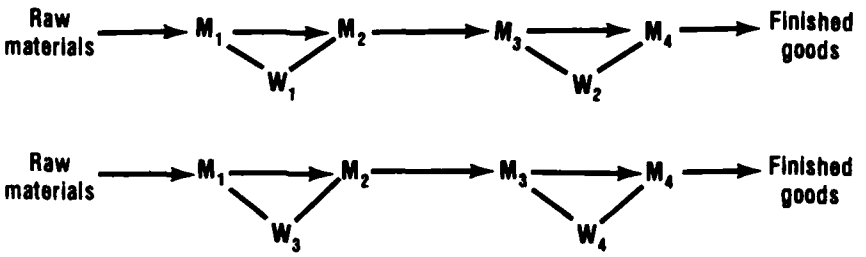


Figure 5. JIT Plant Layout



M — Machine
W — Worker
WIP — Work-in-process

> Improved factory layouts also greatly reduced the need to hold and move large quantities of inventory. Grouping machines according to expected sequence of operations, rather than the traditional grouping according to similarity of function, reduced a product's total travel distance (incoming materials to finished goods shipment) from several miles to several hundred yards, an order of magnitude reduction.

Combined with short setup times (discussed below) the new machine and process configurations should help cut down the size of work-in-process and finished goods inventories and deliver products on time.

Flexible Workforce. The old principle of division of labor is to divide a job into narrow elements. In contrast, JIT prescribes that workers learn multiple job skills; thus, they may be rotated through different jobs in the factory. Line workers are trained to perform other tasks; for example, they perform data collection and analysis, quality control, machine maintenance and minor repairs. Monden explains how a worker in a Japanese auto company manages to operate 16 machines, each performing a different function:[6]

> The laborer, as a multi-function worker, first picks up one unit of a gear brought from the preceding process and sets it on the first machine. At the same time he detaches another gear already processed by this machine and puts it on a chute to roll in front of the next machine. Then while he is walking to the second machine, he pushes a switch between the first and second machines to start the first machine. He performs a similar operation on the second machine and then he moves to the third machine pushing a button again to start the second machine and so on, until he has worked on all 16 machines and finally returns to this initial process. This is done in exactly the cycle time necessary, perhaps five minutes, and so one unit of a finished gear will be completed in five minutes.

Labor flexibility has many benefits. Multiskilled workers can be reassigned to any process to adapt to changes in demand. Workers are not bored because of their variety of tasks. Further, if one worker experiences problems causing delays, others may help in the principle of concentration of forces. Because of the multiskilled nature of such workers, they are less subject to layoff as tasks shift.

Reduced Setup and Lead Time. In a mass production system, setup time is not particularly important because, once the setup is done, it will be used for a long time: There is pressure for making long runs. However, in more competitive and changing circumstances, efforts must be made to reduce setup times so that production can respond to changes in orders placed by customers. How JIT firms accomplish reduction of setup time is described by Schonberger:[7]

> In many cases the solution to the setup time problem is to retire the commercial machine and to have the company's own toolmakers build their own machines. Self-developed machines and tools may be special purpose, lightweight, easily moveable, and low-cost. Furthermore, setup time may be cut essentially to zero! That is, all the worker need is load and unload; since the machine is designed for just one job, all dies, fixtures, and so forth may be built in so that there are no settings or adjustments.

Short manufacturing cycles are important to match orders for finished goods placed by customers on a short-term basis. Only by solving problems that cause delays can lead time be reduced. These problems might include order entry delays and errors, wrong blueprints of specifications, long setup times and large lots, high defect counts, machines breaking down, operators who are not well trained, supervisors who do not coordinate schedules, suppliers that are not dependable, long waits for inspectors or repair people, long transport distances, multiple handling steps, and stock record inaccuracies.[8]

With short setup and lead times, inventories of work-in-process and finished goods are reduced. Manufacturing costs, especially setup and production overhead costs, can be saved. Finally, firms are able to serve customers better.

Total Quality Control. The first priority in traditional mass production is output. Line workers concentrate on production, and quality of finished goods is checked by inspection workers after production has been completed. Statistical sampling techniques are commonly used to determine if the finished product meets standards. A specific percentage of defects is regarded as normal and therefore does not warrant further inspection. Defective items are usually reworked in separate lines so as not to disrupt scheduled output rates.

In the JIT process, since a worker makes only the part immediately necessary at the next work station, the parts must be defect free to continue the work process. Similarly, if only finished goods necessary for immediate sale are produced to minimize the finished goods inventory, products must be defect free to avoid a stockout condition. Hence, in a JIT environment, quality is the primary concern of, and responsibility of, line workers.

Quality of every item, not just a randomly selected sample, is checked, by line workers, while work is being done. Quality control is an ongoing process and the goal is zero defects through defect prevention rather than defect detection. Workers are allowed to stop the production line if a defect is found and the line remains closed until the source of the defect is found and corrected. In one Hewlett Packard plant, a flashing red light and siren are turned on when workers first recognize that a process or work center is producing defective units. The entire production line is shut down until the problem is corrected. As would naturally be expected, when the red light starts flashing, the siren begins blaring and production stops, management de-votes immediate attention to fixing production line problems.[9]

As a result of total quality control, there is a significant drop in rework and scrap which, in turn, helps achieve high quality, low cost, and on-time delivery.

Total Preventive Maintenance. Traditionally, machines are over-used to increase production efficiency and repairs are done by a maintenance department. To achieve zero inventory and zero defects, machines should not break down. Defective machines not only halt production lines; they produce defective items. Moreover, if a machine breaks down frequently, a worker must store parts at his work center so that he can keep working in the event the preceding machine goes down. In JIT firms, regular production workers do the maintenance and minor repairs, rather than waiting for help from maintenance workers. Before the daily work starts, machines are checked and necessary repairs and maintenance are performed. This practice will help produce zero defect products and save costs of major overhaul of machinery.

At Detroit Diesel Allison in Indianapolis and at Harley-Davidson in Milwaukee, machine operators were trained by the maintenance department to lubricate equipment, change bearings, tighten belts, and to do other simple tasks. Results were a significant decrease in machine breakdown, decrease in work stoppage, and increase in life of the equipment. It was reported that workers felt a sense of ownership.[10]

JIT Purchasing

Another reason for maintaining an inventory arises from uncertainty in delivery time and quality of materials. Traditionally, purchases of raw materials are centralized so that large quantities can be purchased at one time. This purchasing practice was justified for three reasons: it saved reordering costs; price discounts could be obtained with volume purchases and delivery could similarly be arranged at reduced rates; and, it prevented stockout of raw materials. In a JIT environment, these benefits can be maintained while resorting to more frequent deliveries of small lots.

Relationships with Suppliers. The basic requirement for successful JIT systems is the reliability of suppliers. Traditional bidding is not desirable because of difficulties in controlling quality and delivery times. Under JIT purchasing, a few reliable suppliers with total quality control commitment are selected for longer periods. In the auto industry, where many JIT pur-

chasing practices originate, suppliers are selected through a certification program that involves a 6-month trial. A significant number of JIT manufacturers in other industries have adopted certification programs. Tektronix selects fewer but more reliable suppliers and certifies them before they can become major suppliers.[11] Many manufacturers provide technical help to suppliers in order to produce zero defect raw materials to the benefit of both sides. For example, Xerox recently conducted a 3-day seminar on JIT for suppliers.[12]

With improved quality and a reliable delivery schedule, manufacturers need not maintain buffer inventories. In addition, if suppliers' plants are geographically near the buyer, there are shipping cost advantages and numerous coordination benefits.

Ordering System. Traditional ordering procedure involves much paperwork: purchase orders, packing lists, bills of lading, invoices, and so on. Other purchasing overhead costs like inspection and counting can be significant. But, JIT purchasing agreements may involve less paper due to the close relationship between manufacturers and suppliers. A blanket order can be placed specifying an overall quantity to be delivered during a period of several months; then, daily deliveries can be arranged by a phone call.

Some JIT firms have developed electronic data interchange systems for communication with suppliers. For example, Caterpillar is using electronic data interchange to issue purchase order release notices against blanket orders previously placed with suppliers. Soon, the company plans to use the system to obtain advance shipping notices, invoices, and quotations from suppliers, and to issue purchase orders and requests for quotation.[13] All information on purchasing is sent via electronic links between the two parties. These electronic links are especially helpful in overcoming long distances separating many suppliers and buyers in the United States.

Suppliers' certification of quality is taken as evidence of good quality. Therefore, materials can be delivered directly to the work stations without stops for counting, inspection, or storage. Since quantities delivered at any one time are small, this additional burden on the work station is minimal. This simplified JIT purchasing procedure reduces reordering costs to a great extent, invalidating the EOQ model.

Delivery and Transportation. Traditional delivery and transportation methods are designed to achieve economies of scale and, hence, cost effectiveness. The JIT manufacturers, however, require suppliers to make frequent deliveries in small lot sizes. Accordingly, suppliers wanting to do business with JIT firms must adapt transportation modes. Suppliers may employ multiple carriers rather than a single carrier and change material packing methods to suit delivery requirements of the purchaser.

Carriers have adopted changes in procedures in response to JIT delivery requirements by suppliers and purchasers. Many trucking companies today are eager to serve JIT firms, and deregulation of the trucking industry in 1980 made it possible for truckers to deliver small orders at low costs. For example, Customized Transportation, Inc., delivers 500,000 modular struts just in time to Delco Products, a GM division. The company delivers 132 different parts for 117 different car models and allows Delco to maintain virtually no inventory at all.[14] The railroad companies try to respond to this challenge. Amtrak's express service is available 365 days a year. Recently, many airline companies expended services for small package deliveries, on time, around the world. Some air carriers currently providing small package express services include Airborne, Air Express International, American Airlines, CF AirFreight, Northwest Orient, Ozark Airlines, Piedmont Airlines, Roberts Air Charter, Target Air Freight, TWA, United Airlines, US Air, and Western Airlines.[15] Their current efforts to reduce shipping costs will make the air transport industry a major player in filling the needs of JIT firms.

Conclusion

The concepts in JIT manufacturing focus on perfection: zero inventories and zero defects. Even though this may never be attainable in reality, this manufacturing philosophy drives these firms toward continual improvement in product quality, inventory management, and customer service. Many U.S. firms are achieving these goals by adopting JIT. More firms in the defense industries are expected to introduce JIT into their existing manufacturing systems. Consequently, more contracts should be made with those firms implementing JIT in the near future. It is crucial for the project manager to understand the new system and the subsequent impact on quality, costs, and delivery schedules. As a consumer, the project manager would benefit from contracting with JIT firms to purchase high quality products at low costs at a scheduled time.■

References

1. Richard Schonberger, *Japanese Manufacturing Techniques*, The Free Press, New York, 1982, p. 83.
2. Richard Schonberger, *World Class Manufacturing: The Lessons of Simplicity Applied*, The Free Press, New York, 1986.
3. "Competitive Jitters Fuel JIT Movement in U.S.," *Purchasing*, January 15, 1987, pp. 33-34.
4. Schonberger, 1982, op. cit., p. 16.
5. H. Johnson and Robert Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting*, Harvard Business School Press, Boston, Massachusetts, 1987, p. 215.
6. Yasuhiro Monden, "Smoothed Out Production Lets Toyota Adapt to Demand Changes and Reduce Inventory," *Industrial Engineering*, August 1981, p. 49.
7. Schonberger, 1982, op. cit., p. 21.
8. Schonberger, 1982, op. cit., p. 68.
9. Rick Hunt, Linda Garrett, and Mike Merz, "Direct Labor Cost Not Always Relevant at H-P," *Management Accounting*, February 1985, p. 61.
10. Schonberger, 1986, op. cit., p. 68.
11. A. Sadhwani, M. Sarhan, and R. Camp, "The Impact of Just-In-Time Inventory Systems on Small Businesses," *Journal of Accountancy*, January 1987, p. 120.
12. "Xerox Preaches the Gospel of Just-in-time to Suppliers," *Purchasing*, October 24, 1985, p. 21.
13. Thomas Dillon, "Caterpillar Connects with EDI," *Purchasing World*, August 1986, p. 62.
14. Schonberger, 1986, op. cit., p.165.
15. Amy Rogers, "Small Package Service Skyrockets with JIT," *Purchasing*, October 10, 1985, pp. 63-66.

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